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AN INSTRUMENTAL SYSTEM FOR THE MONITORING OF VINYL CHLORIDE MONOMER IN PLANT AND LABORATORY WORK ENVIRONMENTS

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Introduction

Within the past several years there has developed a growing awareness of the need to do continuous or sequential sample monitoring of air quality in both laboratory and production work areas. Significant factors contributing to our increased knowledge relating to air quality in polymerization buildings in the PVC industry include the development of suitable instrumentation for the analysis of contaminants and the implementation of these methods, initially on a batch sampling basis. The development of much improved monitoring systems has lead to the ability to do continuous or sequential monitoring (as opposed to batch sampling) by interfacing an analytical instrument with an automatic sampling system. Additionally, the response signal from the analytical instrument now can be feed to a programmable calculator or minicomputer to provide new reporting capabilities such as hourly and shift average concentration levels as well as an instantaneous display and recording of concentration levels at multiple locations.

These much improved sample handling, analytical and data processing capabilities have revealed that the analysis of air quality based on infrequent, batch samples is grossly inadequate. It is also now apparent that even the most advanced instrumental system is not totally adequate because of its limitations in monitoring only from specific, fixed locations, whereas the monitoring needs may frequently be shifted from one location to another. The use of a fixed monitoring system, supplemented by the frequent use of easily portable analyzers having equivalent capabilities, is now recognized as the minimum requirements for both monitoring and maintaining good air quality in polymerization work areas.

As a result of this improved ability to make air quality measurements there has also developed an increased awareness of the many complexities involved in the maintenance of good air quality in an enclosed working area. Good ventilation, the rigid exclusion of leaks and the institution of improved manufacturing procedures are only a part of the practices that must be adhered to. Equally important is the ability to provide early detection and to take immediate corrective action when contaminant levels exceed the criteria established for employee exposure.

Obviously, a monitoring system must therefore be designed to meet the requirements of specific work areas. Preliminary studies must be made to determine excursion limits (maximum and minimum concentrations) of air contaminants and a number of analytical methods must be considered or tested to provide the required measurements. Another important factor is the frequency of sampling and analysis required to provide early warning of high concentration levels and a suitable history of employee exposure. Equally important in the planning stage is proper consideration of data handling since continuous or rapid sequential monitoring from multiple sample locations can produce such a large quantity of data that some means of automated data acquisition, summation, averaging and report writing must be included as a part of the total system.

Instrumental and System Requirements

An instrumental system for the monitoring of vinyl chloride monomer (VCM) in a process or laboratory work area should have the following capabilities or characteristics;

* One ppm detection capabilities (or better),
* Rapid response to changes in concentration levels,
* Linear and reproducible response over a wide concentration range (0 - 1000 ppm),
* Require a minimum of operator attention and maintenance,
* Have the capability of sampling at multiple, remote locations.
* Be compatible with a variety of sampling requirements and data handling methods, such as interfacing to a multi-point recorder, programmable calculator or minicomputer.

Other desirable characteristics of this system should include low or moderate cost, the employment of simple, well accepted concepts and that the hardware and associated electronic equipment be compatible with existing operating and maintenance capabilities in our production plants. It also would be desirable that the instrumentation be of a type currently available from several instrument manufacturers.

Instrument Selection and Evaluation

Data obtained through the analysis of batch samples (using gas chromatography) and survey analyses (using a portable organic vapor analyzer) are sufficient to suggest that two different types of instrumental capabilities are required to meet all of the criteria for effective monitoring and rapid identification of emission sources. The utility of the portable organic vapor analyzer is already apparent in its ability to rapidly and very specifically identify small leaks in processing equipment. It was an early conclusion that an effective total system must include the capability to monitor with both fixed and portable analyzers. The fixed analyzer should monitor a

sufficient number of sample locations in a building so as to provide a continuous record of concentration levels and equally important provide early detection of concentrations exceeding desired levels. When high VCM levels occurred, the portable analyzer would then be employed to more rapidly identify the source and provide the supplemental capabilities needed for immediate corrective action.

The screening of methods having potential for meeting all of the required performance criteria resulted in a select list of instruments for further testing in a production plant environment:

Table 1

Survey Instruments (Portable)	Monitoring Instruments (Fixed)
1. Gas Chromatograph	1. Gas Chromatograph
2. Infrared w/20m gas cell	2. Combustion-Conductivity
3. Catalytic oxidation	3. Infrared w/20m cell
4. Flame Ionization*	4. Flame Ionization*

*Organic Vapor Analyzer (OVA)

Obviously, the above list includes a number of instruments that are now widely used for the monitoring of air quality. Some of these methods (infrared and gas chromatography) have specific component identifying capabilities and some (catalytic oxidation, flame ionization and combustion-conductivity) give a total response to hydrocarbons or halogens. In the early stages of in-plant testing of these methods it soon became apparent that in a majority of PVC polymerization work areas, specific component identification was not required because the presence of atmospheric contaminants, other than VCM, was of little or no concern. Even in those areas where two or more components are present the

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requirement for specific component identification is not required except in those cases where there is a gross difference in the relative toxicity of the individual components.

Comparison of Fixed Monitoring Instruments

The following discussion relating to the evaluation of various types of fixed analyzers for monitoring VCM, will be limited to a general comparison of the relative merits of the methods. Additional detail becomes unnecessary because of obvious, unreconcilable problems involved in use of several of the methods. A more concise summary of the advantages and disadvantages of the various methods investigated is given in Table 2.

Total Hydrocarbon Analyzer

The use of a total hydrocarbon analyzer having a flame ionization detector is the preferred method for the monitoring of VCM with a fixed analyzer for several reasons;

1. Outstanding sensitivity (as low as 0 - 1 ppm full scale; 0.01 ppm minimum detection)
2. Linear response (±2% full scale)
3. Good reproducibility (±2% full scale)
4. Rapid response time (almost instantaneous)

Additionally, the total hydrocarbon analyzer also fills the requirements for unattended operation, minimum maintenance requirements and moderate cost (under $2,000 w/o recorder).

Infrared and Gas Chromatograph Analyzers

Although the infrared and gas chromatographic methods are acceptable

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COMPARISON OF FIXED MONITORING INSTRUMENTS

Method	Advantages of Method	Disadvantages of Method[1]
Total Hydrocarbon Analyzer with Flame Ionization Detector	1. Outstanding sensitivity (0-1 ppm full scale) 2. Linear response (±2% full scale) 3. Good reproducibility (±2% full scale) 4. Rapid response time (almost instantaneous) and cycle time 5. Easy to operate, low maintenance requirements 6. Moderate cost ($2000 w/o recorder)	1. Not specific for VCM
Gas Chromatograph	1. Good sensitivity (low ppm) 2. Acceptable response; good reproducibility 3. Specific for VCM	1. Longer cycle time (5-10 min.) 2. More complex equipment 3. More difficult to operate and maintain 4. More expensive
Infrared Spectrometer w/20m Gas Cell	1. Excellent sensitivity [0.7 ppm MDL[2]] 2. Acceptable response; good reproducibility 3. Specific for VCM	1. Longer cycle time (5-10 min.) 2. More complex equipment 3. More difficult to operate and maintain 4. More expensive
Combustion-Conductivity Method	1. Good sensitivity (low ppm) 2. Specific for halogens	1. Not specific for VCM 2. Longer cycle time 3. Requires excessive operator attention and maintenance 4. Not commercially available

(1) as compared with the Total Hydrocarbon Analyzer

(2) Minimum Detection Limit

in terms of many of the desired performance features, they have the following disadvantages when compared to the total hydrocarbon analyzer;

1. Longer cycle time (2 - 10 minutes)
2. More complex equipment
3. More difficult to calibrate, operate and maintain
4. More expensive (2 to 3 times)

The obvious advantage of infrared and gas chromatography is the ability to measure several components in batch or sequential air samples.

Combustion-Conductivity Analyzer

Although the use of combustion-conductivity was considered as a candidate in the screening of possible acceptable methods, no direct investigation was made to obtain comparative performance data for several reasons. No commercial instruments employing this concept are now available. Also, this method has been extensively explored and used by the Dow Chemical Company for the past ten years. Based on Dow's evaluation(1), this method is a highly acceptable and usable procedure and fills many of the criteria for the monitoring of VCM or other halogenated hydrocarbons in plant work areas. In comparing the combustion-conductivity method with the total hydrocarbon analyzer there are, however, a number of disadvantages;

1. It is a more complex system,
2. More difficult to operate and maintain,
3. More expensive; not commercially available.

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(1) Raymond M. Donahue, "Dow Halogenated Hydrocarbon Analyzer", Instruments Systems Research Laboratory Report, The Dow Chemical Company, Midland, Michigan.

In summary, it can be said that the evaluation of candidate methods was limited to the types of hardware currently available from a number of instrument manufacturers. A suitable method was readily identified. No preference can be stated for one instrument supplier over another.

A primary objective in the screening evaluations was to identify a suitable instrumental method and to then expedite in-plant testing to finalize the design of a total system. The Bendix 8401 Total Hydrocarbon Analyzer was the particular instrument selected for the in-plant testing phase, although similar instrumentation from another supplier could also be considered.

Comparison of Portable, Survey Instruments

The screening of candidate methods (summarized in Table 3) for use as a portable analyzer for VCM was largely influenced by prior, successful use of the flame ionization method as a portable monitor. It also soon became apparent that the comparisons relating to methods for fixed monitoring were, in most cases, translatable to the portable monitoring evaluations.

It should be emphasized that the most important features required in a portable VCM monitoring instrument are rapid response (almost instantaneous), outstanding sensitivity (1 ppm or better detection capabilities) and the equipment should be light weight and easy to handle and operate. Good linearity over a wide range of concentrations and reproducibility are desirable features, although not as critical as with the fixed monitor. Keep in mind that the major function of this instrument is to find leaks and emission sources as opposed to the continuous, quantitative requirements of the fixed analyzer. It also is desirable that the instrument be explosion proof or suitable for use in a Class I, Group D area.

COMPARISON OF PORTABLE SURVEY INSTRUMENTS

Method	Advantages of Method	Disadvantages of Method[1]
Organic Vapor Analyzer (OVA) with flame ionization detector	1. Good sensitivity (low ppm) 2. linear response (1-1000 ppm) 3. Good reproducibility 4. Rapid response (almost instantaneous) 5. Light weight; easily portable 6. Easy to operate and maintain 7. Moderate cost (<$3,000)	1. Not specific for VCM 2. Not approved for use in a Class I, Group D work area[2]
Gas Chromatography	1. Good sensitivity (low ppm) 2. Acceptable response; good reproducibility 3. Specific for VCM 4. Excellent for multi-component mixtures	1. Lacks instantaneous response for leak detection 2. Not as easily portable as OVA
Infrared Spectrometer w/20m Gas Cell	1. Excellent sensitivity [0.7 MDL[3]] 2. Linear response; good reproducibility 3. Specific for VCM 4. Good for multi-component mixtures	1. Lacks instantaneous response for leak detection 2. Not easily portable 3. Not explosion proof; requires exclosure with N_2 or air purge
Catalytic Oxidation	1. Easily portable 2. Explosion proof 3. Good response at high concentrations	1. Lacks sensitivity (not reliable below 50 ppm) 2. Bad zero level drift

(1) as compared with the Organic Vapor Analyzer

(2) Requires Hot Work Permit

(3) Minimum Detection Limit

Table 3

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Portable Organic Vapor Analyzer

The portable flame ionization instrument (Century Organic Vapor Analyzer) gives an almost instantaneous response to changes in VCM concentrations. It has excellent sensitivity (<1.0 ppm minimum detection limits) and gives a linear readout over a wide range of concentrations. The instrument is light weight, compact and easily transportable. It provides an excellent method for the detection and location of small leaks in processing equipment. Although the Century OVA is rated as being intrinsically safe for use in most PVC processing areas it has not yet been approved by Factory Mutual, or other rating agencies, for use in a Class I, Group D area. Such approval is expected however by mid-1974. Standard work practices involving the use of non-rate equipment in such areas need to be rigidly adhered to (such as air testing and the issuing of a Hot Work Permit).

Portable Gas Chromatograph

The use of a portable gas chromatograph having a flame ionization detector has a number of distinct advantages including the ability to specifically separate and measure VCM in the presence of other organic vapors. This advantage, however, is responsible for several undesirable features of the method, namely increased analysis time and additional requirements for operation and calibration of the instrument. The inability to provide an almost instantaneous response is sufficient to preclude the gas chromatograph as an effective method for VCM leak detection. Its primary utility is in providing analysis of batch samples in work areas where multicomponent mixtures are present.

Portable Infrared Analyzer

The infrared instrument (Wilkes Scientific Corp. Miran Gas Analyzer)

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evaluated as a portable VCM analyzer had excellent sensitivity (0.7 ppm minimum detection). The major disadvantages of this method is the lag in response time (several minutes) due to the 5 liter volume of the variable path length gas cell and the time required for flushing between samples. This limitation makes this method insensitive in rapidly detecting changes in VCM concentrations when the sample probe is moved from one location to another. The instrument is too bulky to conveniently use as a portable analyzer. It also is not explosion proof. In the in-plant evaluation the instrument was mounted in an air tight box and kept under a positive pressure using a N_2 purge. This seriously limits the mobility of the instrument. It was also found that the housing for the detector is not light proof and that there is a change in zero level when the instrument was exposed to direct sunlight.

Portable Catalytic-Oxidation Analyzer

The Catalytic Oxidation method (Bacharach Instrument Company's J-W Analyzer) did not meet our performance criteria for several reasons, the most important being lack of sensitivity (minimum detection limit of 10 ppm) and baseline (zero level) drift. The instrument is apparently responsive to temperature changes or other exposure conditions and over a relatively short period of time the zero level can change in amounts equivalent to 100 ppm of VCM.

In summary, it was concluded, based on the evaluation of these several methods, that the Organic Vapor Analyzer equipped with a flame ionization detector is the preferred type of instrumentation for use as a portable analyzer for VCM in ambient air.

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The Total Instrumental Monitoring System

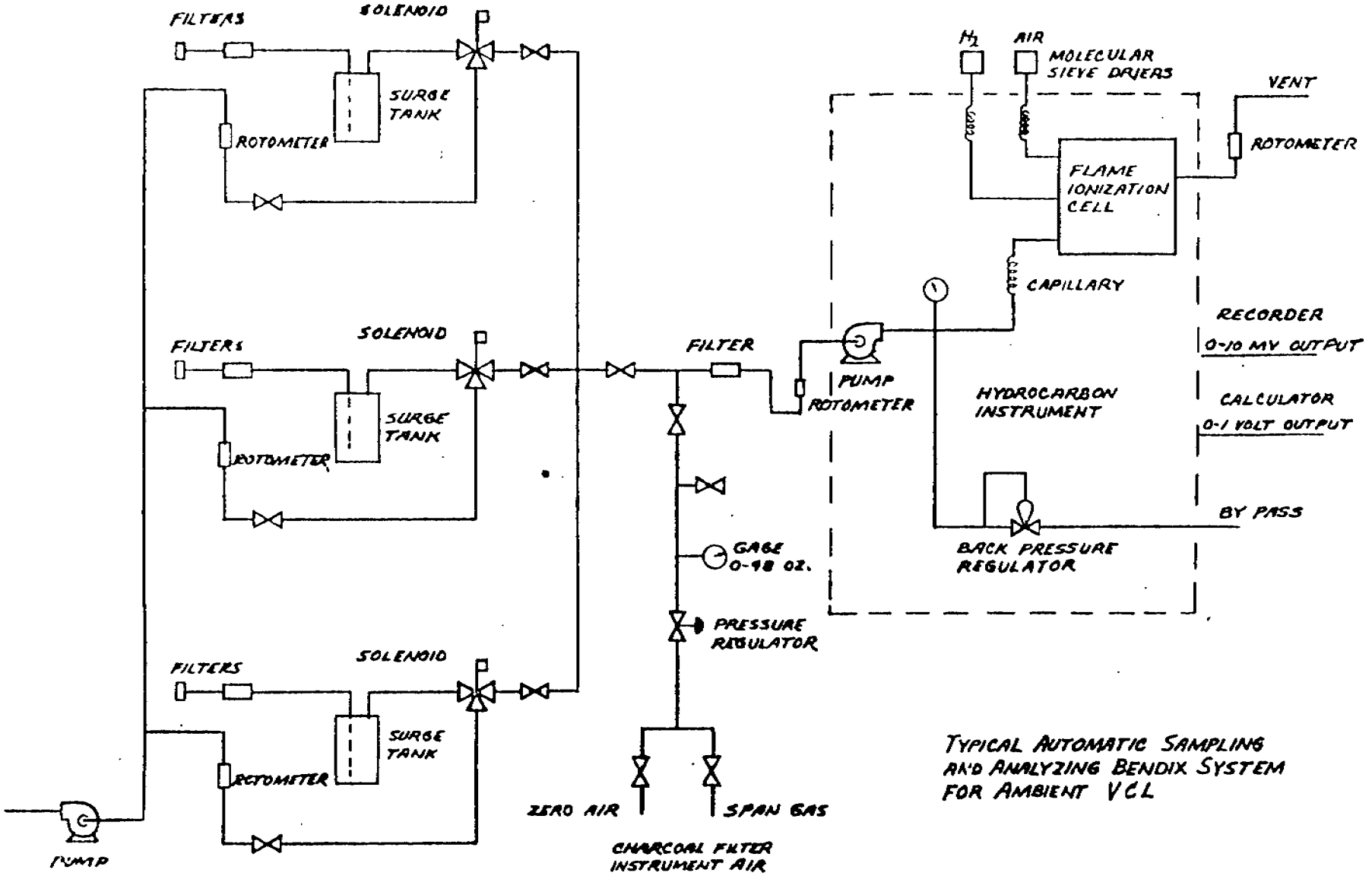
A total instrumental system for the monitoring of VCM in ambient air includes, in addition to the flame ionization instrument, an automatic, multi-point gas sampling system, a multi-point recorder, and other means of data collection such as a programmable calculator or mini-computer and the necessary hardware for interfacing these components. A basic diagram of the instrument and sampling system is shown in Figure 1.

The Flame Ionization Instrument in a Fixed Monitoring System

This unit is designed for unattended operation over long periods of time without the necessity for adjustment or any type of manual operation. The instrument is housed in a metal case suitable for either bench or rack mounting ($16\frac{1}{2}$" X $8\frac{1}{2}$" X 18") and weighs approximately 40 pounds. The analyzer utilizes all solid state electronic components mounted on plug-in type printed circuit boards.

The utility requirements include a 115 volt power supply (150 watts) and a cyclinder of hydrogen for the operation of the burner in the analyzer. The hydrogen consumption rate is about 45cc/min.

The analyzer package (see Analytical Flow Description, Figure 2) includes an internal sample pump and sample pressure regulator as well as the necessary capillary flow controls and indicating pressure gauges to provide a very stable flow of hydrogen, air and sample gas. The analytical components in contact with the sample should be either glass or stainless steel to minimize corrosion. Some of the components in the flame ionization cell (bonnet and guiderods) should be Teflon coated to prevent corrosion from the HCl produced from the combustion of VCM.



Typical Automatic Sampling and Analyzing Bendix System for Ambient VCL

Figure 1

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Analytical Flow Description

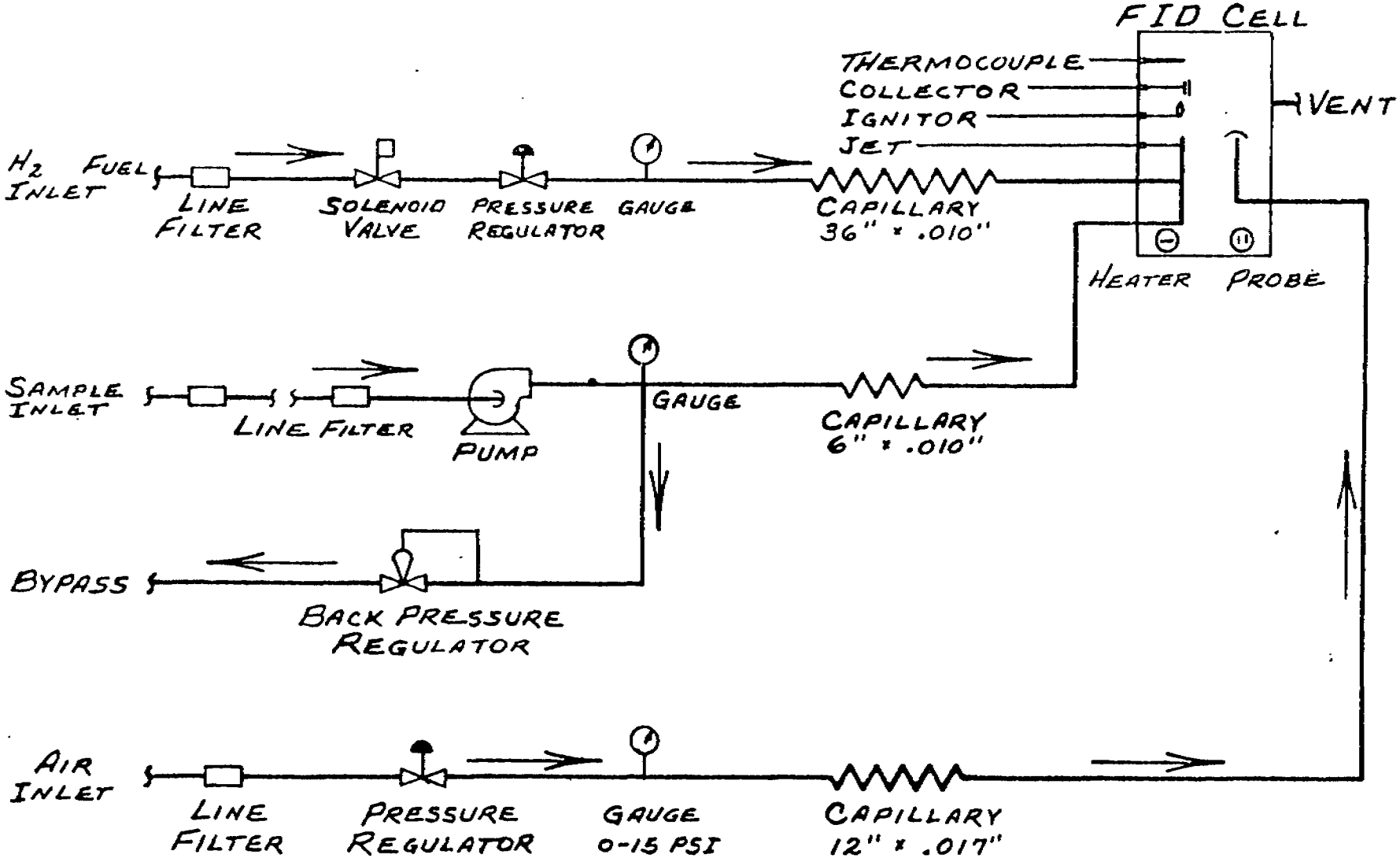

Figure 2

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This type of analyzer can operate over a wide range of temperature and humidity conditions without adverse effect on measurement accuracy. The sample is introduced at a controlled rate into the flame ionization cell where a hydrogen flame is burning in an atmosphere of air. As the sample enters the flame a percentage of the molecules are ionized, forming positive and negative ions. The extent of ionization depends on the compounds present (composition and structure) and the temperature of the flame. As a general rule, compounds must have carbon-carbon or carbon-hydrogen bonds to be detectable. The degree of ionization is roughly proportional to the number of carbon atoms per molecule. Inorganic materials such as hydrogen, oxygen, nitrogen and water are not ionized. The positive ions formed in the flame are collected on a negative electrode producing a signal that can be measured using the output of an electrometer preamplifier.

The Automatic Sampling System

The interfacing of the automatic sampling sytem to the flame ionization instrument is shown schematically in Figure 1, including the manifold for the zero and span gas cylinders necessary for calibration of the instrument. It should be noted that sample pumps are included in both the analyzer and sampling system. The sampling system pump continuously pulls samples from six remote locations to the instrument inlet manifold. This reduces lag time to a few seconds. The sample valves are operated by a mechanical switching device in the multi-point recorder on a 2 minute cycle. The concentration level (ion current calibrated for VCM) is recorded on the strip chart recorder and a suitable signal is provided for a continuous digital read-out.

Sample points can be located up to 150 ft. from the instrument. The location and number of sample points required should be determined by an

analysis of building ventilation patterns and many other factors including process equipment locations that can result in VCM emissions and employee work area definitions. Sample points in employee work areas should be located at about breathing level (approximately 5 feet above the floor). The lines from the sample point to the sampling system manifold are 3/8" OD polypropylene tubing and contain two filters to prevent the introduction of polymer or dust into the sampling system or analyzer. The balance of the components in the sampling system are constructed of stainless steel. A one liter surge tank is included in each sample line. This addition was made to prevent the recording of rapid changes in concentration levels that apparently occur as a result of rapid vertical movement of thin VCM layers in the atmosphere. The surge tank provides sufficient mixing and compositing action (30 seconds) to smooth out the instrument and recorder response to these types of spikes.(2)

Recorder and Data Collection

A variety of options are available for the collection and recording of data from the VCM analyzer system. The system shown schematically in Figure 3 is capable of handling a single analyzer with 6 sample points. This system consists of a six-point recorder, a digital readout meter, digital clock and a 110 volt AC to 5 volt DC converter and other required hardware for interfacing to a programmable calculator (Wang Model 720C).

Concentration levels are recorded by the 6-point recorder during each sampling cycle. Additionally, a signal is provided to the digital read-out meter and the programmable calculator. The calculator stores and averages data from each sample point to provide hourly and shift reports that are typed

(2) This phenomenon is not completely understood. It suggests that transport of VCM in air may be much like the waving action of a heavy smoke.

Data Collection System

Flame Ionization Instrument

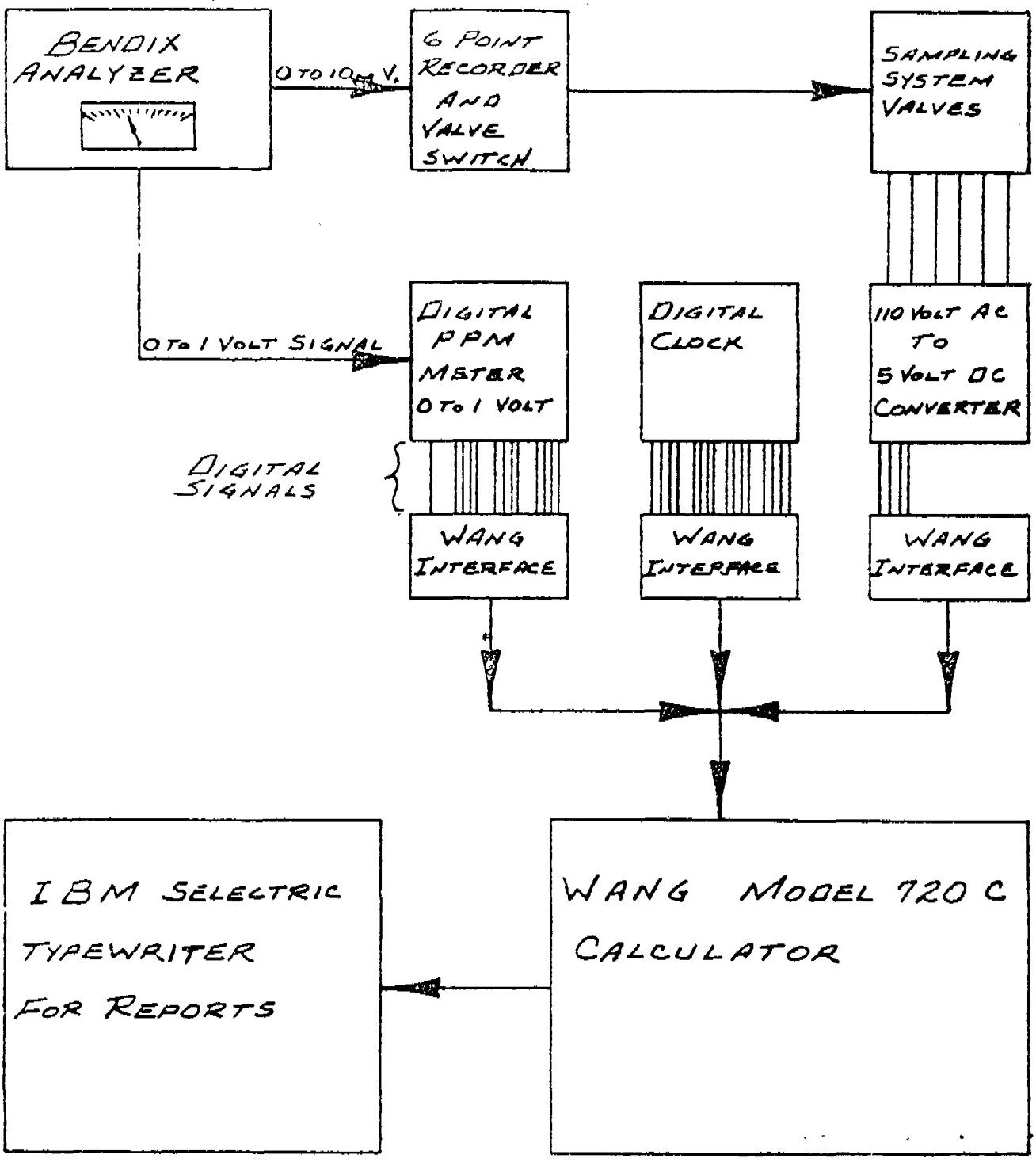

Figure 3

out on an IBM typewriter. The hourly report is an average of concentration levels at each sample point in ppm. The shift report includes an 8 hour average of concentration level at each sample point plus a summary of maximum peak levels and time of occurrence for each hour during the shift period. The shift report also includes a summary of percent of time that VCM concentration level exceeded the maximum allowable concentration of 50 ppm.

Fixed Station Monitoring vs. Personal Monitoring

The use of fixed station monitors for the sampling and analysis of ambient air in a production plant is only one approach that can be used in determining an employee's exposure index. The obvious disadvantage of fixed station monitoring is its fixed nature as opposed to mobile personnel. Multiple station sampling capabilities are, therefore, essential to cover all of the areas of employee exposure. Additionally, the determination of a Time Weighted Average for an employee must include a calculation of concentration vs. time to obtain a total exposure index. This accuracy of this method is obviously dependent on the ability to measure the concentration levels in all areas of exposure and also to accurately estimate the amount of time the employee spends in each work area.

In comparing the use of a fixed station monitor with a personal monitor (a portable device worn by each individual) there are also some obvious advantages in using the fixed station concept. Firstly, it provides an instantaneous display of concentration level and obviously provides the best signal (alarm) for instituting corrective action. On the other hand, the personal monitor provides only a history of events that are averaged out over a period of hours. Most types of personal monitoring devices will only reveal an overexposure to

a toxic substance after it has occurred. The fixed station monitor can warn you before overexposure occurs. The other obvious disadvantage of the personal monitor is that it must be worn by the individual which can create problems due to bulk, weight, vibration or just because it's a continuous reminder of the problem. A comparison of the costs of the two methods will, in general, show that a fixed station monitoring system will have an initially higher hardware cost while the personal monitor will have a higher sustaining analytical cost, particularly when measurements are required for large numbers of employees.

Although the evaluation of personal monitoring equipment was not a specific objective relating to the previously described instrumental evaluations, the need for this capability is now most obvious. The ultimate evaluation of a fixed station monitoring system in measuring an employee's exposure index must include some means of personal monitoring. The acceptance of a fixed station system is dependent on obtaining reasonable agreement with data obtained from a personal monitoring program. Several methods of personal monitoring are detailed in the literature[3][4][5]. Each of these methods, however, may require some further refinement or need to be modified to meet specific monitoring requirements in PVC production work areas.

Summary

An analysis of the problems relating to the monitoring of vinyl chloride

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(3) A. A. Allemang and R. A. Goudeau, "Monitoring Personnel Exposure to Chlorinated Hydrocarbons in an Industrial Work Environment", Personal Communication, Dow Chemical Co., March 30, 1973.

(4) E. . . Palmes and A. F. Gunnison, "Personal Monitoring Device for Gaseous Contaminants", J. of Amer. Ind. Hyg. Assoc., pp. 78-81, Feb. 1973.

(5) Edward D. Baretta, et.al., "Monitoring Exposures to Vinyl Chloride Vapor: Breath Analysis and Continuous Air Sampling", J. of Amer. Ind. Hyg. Assoc., Vol. 30, p. 537-544, Nov.-Dec., 1969.

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monomer (VCM) in laboratory and production work areas has shown that two different types of monitoring capabilities are required; a fixed analyzer with multi-point remote sampling capabilities and a portable analyzer for rapid area survey analyses and leak detection.

An evaluation of commercially available instrumental methods has revealed that the flame ionization method for monitoring low concentrations of VCM in ambient air has distinct advantages over other procedures investigated. These advantages include outstanding sensitivity (0.01 ppm minimum detection), and good linearity and response (±2%) over a wide range of concentrations (0 - 1000 ppm). Additionally, the analyzer is moderate in cost (approximately $2,000) and can be easily interfaced to a multi-point sampling system and continuously operated on a two minute per-sample-point cycle for long periods of time with a minimum of operator attention or maintenance.

A fixed monitoring system utilizing a flame ionization instrument (Bendix 8401 Total Hydrocarbon Analyzer) has been in continuous operation in a PVC poly building, at the B.F.Goodrich Chemical Company plant in Avon Lake, Ohio, for approximately six months. This system which includes, in addition to the analyzer and a six point sampling system, a multi-point recorder, interfacing hardware and a programmable calculator for data reporting on a hourly and shift basis. The operation of this system has been essentially trouble free during this period and has provided the types of measurements required to determine VCM concentrations in a multi-story building and to minimize employee exposure levels.

An important adjunct to this system is the portable survey instrument that has outstanding utility in rapidly determining the source of VCM leaks

in processing equipment. This instrument (Century Organic Vapor Analyzer[6]) also uses the flame ionization principle. It is light weight, easily portable and has sensitivity and linear response roughly equivalent to the fixed analyzer. Equally important, and highly essential in leak detection, is this instrument's instant response to VCM.

Recommendations

The previously described evaluation of various instrumental methods and the subsequent testing of a total system in a plant working environment has been sufficient to conclude that these procedures can be easily applied to a variety of work areas where the monitoring of VCM in ambient air is a criteria for employee health and safety. It, therefore, can be recommended that the identified methods, or their equivalent, be adopted as standard industry practices. Standard operating procedures detailing the start-up, operation, calibration and instrument maintenance are included in Appendix I (Fixed Analyzer) and Appendix II (Portable Analyzer).

Acknowledgments

The author would like to recognize the contributions of the large number of people who participated in this work. A particular debt of gratitude is owed to L. W. Salzer for his wisdom in selecting specific instrumental methods for testing; to M. D. Rider for his invaluable contributions to the in-plant testing; and to M. E. Forsythe for his assistance in interfacing the analytical and data collection systems.

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(6) Century Systems Corporation; Arkansas City, Kansas.

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STANDARD OPERATING PROCEDURE

Bendix Total Hydrocarbon Analyzer

I. Scope

This procedure is a method for the determination of vinyl chloride in air by the hydrogen flame ionization method.

II. Discussion

The vinyl chloride content of the building air shall be determined to comply with the company criteria for maximum allowable exposure of 50 ppm. The sample is introduced into the Flame Ionization Detector (FID) cell under pressure where a hydrogen flame is burning in an atmosphere of air. The resulting burning of the sample produces an electrical output signal which is proportional to the amount of hydrocarbon (vinyl chloride) in the sample. The output voltage is then indicated on the output meter, recorder and calculator.

III. Safety

1. The Bendix THA and recorder are non-explosion proof, therefore, requiring installation in a control room or warehouse area.

2. Hydrogen gas, when mixed with air, is highly flammable. Avoid any sparking conditions during cylinder changes. Do not disconnect hydrogen lines with open fires in the area.

3. Do not attempt to remove the FID cell until certain that it has cooled sufficiently to prevent burns to personnel.

4. Do not remove or replace electronic cards with power on. Use care to avoid personal contact with electrical contacts while the instrument or recorder is operating.

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Appendix I

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5. Installations of sample probes five feet from the floor level should be placed in non-critical path areas avoiding personnel contact.

IV. Startup Procedure

Prior to performing the startup procedure, ensure that the POWER switch, and SUPPRESSION switch are in the OFF positions and the ATTENUATION switch is set to X10.

To perform system startup, complete the following tasks in the sequence indicated:

1. Adjust charcoal filtered instrument air to a nominal 25 psig setting.
2. Adjust the hydrogen cylinder output pressure to a nominal 25 psig setting.
3. Adjust the hydrogen pressure on the Bendix front panel to a nominal 5 psig setting.
4. Adjust the air pressure on the Bendix front panel to a nominal 6 psig setting.
5. Turn POWER switch ON.
6. Place the ignitor switch in the IGNITE position. Hold the switch in this position until the flame out light goes off. If the flame out light comes on again, place the switch in the IGNITE position again and hold for a long period of time.

V. Setting Instrument Zero

At initial startup, or following extended periods of non-operation, the instrument zero must be set prior to calibration and operation. In these cases, perform the startup procedure and allow the instrument to operate for a minimum of 60 minutes to allow the system to stabilize. After instrument stabilization, or if the unit has been in operation and a routine zero check is being made, proceed as follows:

NOTE: First take Wang calculator off line by pressing PRIME.

1. Open the activated carbon filtered instrument air by-pass line and assure a maximum pressure of 28 oz. pressure using the Watts pressure regulator. CAUTION: Excessive pressure to the analyzer pump will rupture the pump bellows.
2. Open the AIR valve & close MAIN SAMPLE SHUT OFF valve simultaneously on the Bendix automatic sampling system.

3. When the output meter on the Bendix front panel has stabilized, unlock the SUPPRESSION control knob and adjust to zero. The ATTENUATION switch is set to X1 for zeroing. An acceptable zero is in the 0 to 0.05 ppm range on the output meter.
4. Set the ATTENUATOR knob to ~~X300~~ X1000 and assure a zero reading on the 6 point recorder.
5. Shut off the filtered instrument air bypass line.
6. Close the AIR valve and open the MAIN SAMPLE SHUTOFF valve simultaneously on the Bendix automatic sampling system.

VI. Calibration

1. Open the vinyl chloride in air (110 ppm) compressed gas cylinder valve.
2. Adjust the 2 stage gas regulator to a nominal 25 psig setting.
3. Open the VCl gas shutoff valve and assure a maximum pressure of 28 oz. pressure using the Watts pressure regulator.
4. Open the VCl valve and close the MAIN SAMPLE SHUTOFF valve simultaneously on the Bendix automatic sampling system.
5. When the output meter has stabilized, unlock the RANGE knob and adjust the output meter to read a nominal ~~25~~ 110. The recorder reading should be set exactly to read ~~25 PPM~~ 110. The ATTENUATOR has been previously set at ~~X300~~ X1000 for a 110 ppm standard.
6. Shut off the vinyl chloride compressed gas cylinder valve.
7. Close the VCl valve and open the MAIN SAMPLE SHUTOFF valve simultaneously on the Bendix automatic sampling system.

VII. On Stream Analysis

1. Set ATTENUATION knob to X1000.
2. Assure the 6 rotameters are equally balanced at 4 LPM.
3. Press GO on the Wang calculator.

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4. Note calibration on Wang typewriter printout, L & N recorder, and log sheet. Also note hydrogen gas cylinder pressure, suppression setting, range setting, and the Bendix pump bypass flowmeter reading on the log sheet. Weekly zero and calibration checks are required.
5. Presently 0-300 ppm data is displayed on the L & N recorder and 0-1000 ppm data is displayed on the Wang calculator typewriter.

VIII. Complete Shutdown Procedure

1. Push PRIME on the Wang calculator.
2. Move Bendix THA POWER switch to the OFF position.
3. Close the AIR SUPPLY shutoff valve.
4. Move Bendix sampling system pump switch to the OFF position.
5. Move the recorder power switch to the OFF position.
6. Remove top fuse inside recorder to deactivate solenoid mechanism.

IX. Routine Maintenance

1. Clean in-line Hoke filters and the $\frac{1}{4}$" Swagelok filter in the sample line if the bypass flow meter reads less than 1.5 LPM.
2. Replace the MSA sample inlet filter cartridge once every six months.
3. Replace the activated carbon filter on the instrument air supply once every 6 months or if the suppression setting approaches 800.
4. Replace the hydrogen gas cylinder supply when cylinder pressure declines to 100 psig. A full cylinder has an approximate $4\frac{1}{2}$ month service life.
5. Molecular sieve driers on the hydrogen and air lines should be dried in an oven at 105°C. for 4 hours every six months to drive off the moisture.
6. Replace the chart paper on the recorder once every $2\frac{1}{2}$ weeks.
7. Replace the ink pad wheel on the recorder when the readout becomes faint. Depressing the ink pad with a sharp point may bring additional ink to the pad surface.

X. Hydrogen Cylinder Replacement

1. Push the PRIME button on the Wang calculator.
2. Move the Bendix POWER switch to the OFF position.
3. Close the hydrogen cylinder valve.
4. Turn the two-stage regulator fully counter clockwise and remove the regulator from the cylinder.

5. Slightly open and close the new hydrogen gas cylinder valve to blow out foreign particles.

6. Connect the new cylinder to the regulator (left hand threads).

7. Open the cylinder valve and adjust the two-stage regulator for a pressure of 25 psig.

8. Turn instrument power ON.

9. Assure hydrogen pressure gauge on the Bendix front panel reads a nominal 5 psig.

10. Allow a minimum of 10 minutes for air to purge from the system and ignite the flame.

11. Perform the zero and calibration procedure 10 minutes after the instrument has come to equilibrium. Refer to Sections V, VI, and VII.

XI. Trouble Shooting

Refer to the attached Trouble Analysis Chart.

If a malfunction is suspected and all controls appear to be operating properly, refer to the Service Manual for the trouble shooting and repair procedures. The procedures contained in the Service Manual are designed for use of technically qualified personnel only.

The use of the manual by unqualified or inexperienced personnel is not recommended. The Total Hydrocarbon Analyzer is a precision instrument and can be damaged by improper handling and maintenance.

This above statement also applies to the L & N Speedomax "H" recorder.

XII Reference

Bendix Series 8400 Total Hydrocarbon Analyzer Installation and Operation Manual.

Bendix Series 8400 Total Hydrocarbon Analyzer Service and Maintenance Manual.

L & N Speedomax H & W Multipoint Recorder Manual, Directions 177304, Issue 7, and
Addendum to Directions 177304, Issue 7.

XIII. For Service & Technical Information Contact

Clay Cook Ext. 277
Electrical & Instrument Foreman

Doug Rider Ext. 554 or 553
Environmental Engineer

Lou Salzer Ext. 297
Process Instrument Consultant

Mark Forsythe Ext. 485
Electrical and Electronics Engineer

bp

Table 2-1. Trouble Analysis Chart

Symptom	Probable Cause	Corrective Action
Panel meter fails to indicate.	Power cord disconnected.	Connect power cord.
	Blown fuse.	Replace fuse.
	Power switch is OFF.	Turn power ON.
	Electrometer card inoperative.	Replace electrometer card.
	Power supply card inoperative.	Replace supply card.
	Defective meter.	Replace meter.
Excessive meter noise.	Contaminated hydrogen.	Replace H_2 cylinder.
	Contaminated air.	Replace air cylinder.
	Moisture in FID cell.	Ensure that temperature is at least 80°C.
	Defective power supply card.	Replace supply card.
	Leak in H_2 or air system.	Repair leak.
	Defective coaxial cable.	Replace cable.
	Excessive variation in ac supply.	Obtain correct supply source.
	Weld joint on collector is broken.	Replace collector.
Flame out light illuminated.	H_2 or air supply depleted.	Replace as necessary.
	Defective H_2 shutoff solenoid.	Replace solenoid coil or solenoid as required.
	Excessive sample flow.	Correct to flow rate specified in Operational Data Sheet.
	Plugged capillary.	Replace capillary. Check filters and replace all that are dirty or clogged.
Sample pressure gauge indicates zero pressure.	Inoperative pump.	Replace pump.
	Plugged filter.	Replace or clean filter.

1 Sample Inlet
2 Pump, High Temperature
3 Cell Vent
4 Bypass
5 H_2 Inlet
6 Air Inlet
7 Fan
8 Filter Card
9 15 VDC Power Supply Card
10 Converter Card
11 Auto Ignitor Card
12 110 VDC Power Supply Card
13 Resistor Card
14 Resistor, 1×10^{12} (1,000,000 Meg)
15 Capacitor, 22 PF
16 Resistor, 1×10^{10} (10,000 Meg)
17 Microdot Connector (to card)
18 Air Valve & Indicator
19 Fuel (H_2) Valve & Indicator
20 Meter
21 Sample Valve
22 Sample Pressure Indicator
23 Heat Shield
24 Pump Motor
25 Cell

Symptom	Probable Cause	Corrective Action
	Incorrect pressure.	Set pressure to conform to setting specified in Operational Data Sheet.
H_2 pressure gauge indicates zero pressure.	Hydrogen Generator is off or cylinder is depleted.	Turn on generator or replace cylinder.
	Defective pressure regulator.	Replace regulator.
	Line plugged.	Clean or replace line. Check filters and drier and clean or replace as necessary.
Air pressure gauge indicates zero pressure.	Air supply is depleted.	Replace air cylinder.
	Defective pressure regulator.	Replace regulator.
	Line plugged.	Clean or replace line. Check filters and drier and clean or replace as necessary.
	Flame is off.	Reignite and check pressure.
Total hydrocarbon measurements are abnormally low.	Incorrect H_2 or air flow.	Correct as necessary.
	Incorrect sample pressure.	Check pump, filter, and lines. Clean and replace as necessary.
	Incorrect position of ignitor coil.	Check position for proper location. (See Figure 2-3).
	Defective electrometer or power supply card.	Replace as necessary.
	Zero improperly adjusted.	Readjust correctly.
	Calibration improperly adjusted.	Readjust correctly.

If the trouble is traced to the fuse, a printed circuit card, a pressure regulator, the sample pump or the FID cell, refer to Removal and Replacement Procedures.

ELECTRONIC SYSTEM

The electronic system consists of a 110 vdc power supply, an electrometer amplifier, and an auto ignitor containing a relay for H_2 shutoff control. The system also includes a detector cell temperature control and attenuator and range adjustments for calibration of the electrometer output. Optional electronics for creating a current output include a 15 vdc power supply regulator, a filter and a voltage to current converter. The functional relationship of these components is shown in the block diagram, Figure 2-2. Schematic diagrams are provided in Section 4.

PRINCIPLE OF ELECTRICAL/ELECTRONIC OPERATION

When the power switch is turned on, 115 vac is fed simultaneously to the rectifier circuit, the pump motor, the

fan motor, the ignitor switch, the H_2 shutoff relay, and the detector cell temperature control.

The 110 vdc power supply card operates from a rectified source of approximately 140 vdc which is obtained by changing the 115 vac to dc. The output of the 110 vdc power supply card is a regulated 110 vdc which is fed to the suppression adjustment control and the electrometer amplifier.

The electrometer amplifier receives an additional input signal from the FID cell which determines the electrometer output voltage. The electrometer output is 0 to −100 vdc which is then simultaneously fed to the range adjustment control (which in turn feeds the attenuator switch providing attenuation adjustment to the flame cell collector), the output meter, the voltage outputs and, when installed, the voltage to current converter. The electrometer output is reduced at the output circuits for the 0 to 1 vdc and 0 to 10 mv outputs to the recorder. The 0 to −100 vdc input is transformed to 0 to −10 vdc for conversion to the current output.

When the converter is installed, the source power of 115 vac is transformed to 25 vac by transformer F-90X for the auto ignitor/H_2 shutoff card and the filter card. The 25 vac is a nominal voltage and the instrument operates satisfactorily when the voltage is anywhere between 16 and 30 volts. The input voltage is rectified as it enters the filter card and the auto ignitor card. The filtered output of the filter card is then fed to the input of the 15 vdc power supply card and the converter card. Regulated 15 vdc from the power supply card is fed to the converter card for Q1, Q2, Q3 and Q4. Q5 receives power from the 16 to 30 vdc provided from the filter card.

ELECTRONIC TROUBLESHOOTING

Electronic troubleshooting should be performed only by qualified technical personnel. The high voltages contained within the instrument may be hazardous to anyone unfamiliar with testing electronic equipment.

When troubleshooting the electronics, a strip chart recorder with a range of 0 to 10 mvdc and a chart speed of 0.5 or 1 inch per minute and a multimeter of suitable range is required. Unless otherwise specified, all dc voltages are referenced to ground.

CAUTION

When measuring voltages on pins at bottom of cards, use caution to prevent shorting pins together or to ground. Do *not* remove or replace cards or components with power on.

A card extender is available from Bendix to aid in measuring voltages on cards. The card extender, Part Number 5512457, raises the card to a position where test points are more accessible, thus reducing the danger of shorting contacts.

Sensitive electronic components can be destroyed by shorting of contacts. The use of alligator type clips on card pins is *not* recommended.

When a card is indicated to be defective, replace with a new card and recheck.

NOTE

Before replacing a card, it is recommended that the card be rechecked to verify original findings.

TESTING THE 110 VDC POWER SUPPLY CARD, Part No. 5511109

This card (located in socket J2) supplies + and −110 vdc for jet potential and suppression current. To determine if this card is functioning properly, refer to the master schematic and perform the following checks in the sequence indicated.

1. Check from pin 1 to ground for +140 vdc ±10 v. If voltage is not present, remove the card and retest at the card socket. If voltage is still not present, a defective transformer or rectifier is indicated. If voltage is present, a defective 110 vdc card is indicated.

2. Check from pin 2 to ground for −140 vdc ±10 v. If voltage is not present, remove the card and retest at the card socket. If voltage is still not present, a defective transformer or rectifier is indicated. If voltage is present, a defective 110 vdc card is indicated.

GENC 000199

B.F.Goodrich Chemical Company
Avon Lake General Chemical Plant
Avon Lake, Ohio

STANDARD OPERATION PROCEDURE

Century Organic Vapor Analyzer

I. Scope

This procedure is a method for the determination of vinyl chloride in air by the hydrogen flame ionization method.

II. Discussion

The vinyl chloride content of the building air shall be determined to comply with the company criteria for maximum concentrations and T.W.A. and to identify source leaks greater than the maximum allowable exposure of 50 ppm. The vinyl chloride content of poly evacuation blower exhausts, blend tank exhausts, dryer exhausts, and recovery vents shall be determined to comply with EPA regulations and plant efficiency standards.

III. Safety

1. The Century OVA is rated intrinsically safe but does not have Factory Mutual approval to date, therefore, the following precautions shall be taken in a Class I, Group D area.

   A. A Hot Work Permit will be required.

   B. The instrument shall be On prior to entering the area. If a flameout occurs, the instrument shall be restarted outside the area.

   C. Only authorized personnel who have been fully trained and approved by both the general foreman and plant safety engineer shall operate the instrument.

2. Open flames and no smoking shall be observed during the hydrogen fill operation. Hydrogen gas, when mixed with air, is highly flammable.

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e issued: January 9, 1974 By: M. D. Rider

GENC 000200

3. Do not fill the hydrogen tank beyond the maximum rated pressure of 2300 psi. The hydrogen tanks used in the instrument are made from stainless steel, proof-tested to 6000 psi and 10% production tested to 4600 psi.

4. Maintain the sample flow above 1.5 LPM to prevent a hydrogen rich atmosphere causing an explosion in the combustion chamber. The teflon chamber will not rupture.

5. Use only the fuses supplied with the instrument. Do not depress igniter button longer than 5 seconds. Wait 15 seconds between depressions to prevent fuse overload. The battery pack has two (2) power circuits, one for the pump motor and igniter and the other for the electronic circuits. Both circuits have resistive current limiting to restrict the short circuit current to an intrinsically safe level. In addition to the current limiting, there is a fuse (1 amp. slo-blow and $\frac{1}{4}$ amp.) in each line to protect against overload conditions.

6. Do not operate the instrument without the hydrogen flow restricter, inlet and outlet scintered stainless steel flame arrestors.

IV. Battery Check

Move Instr/Batt test switch to the Batt Test position and insure battery is charged by reading the indication on the readout meter.

V. Turn On Procedure

1. The gas selector adjust should be preset to the desired dial indication prior to turn-on. ALGC Unit No. 1 has a vinyl chloride set point of 460 for the 1-1000 ppm range.

2. Move the INSTR switch to ON and allow one minute for warm-up.

3. Move CALIB switch to LOW and verify the meter reads 10 ppm. If not, adjust meter reading to 10 ppm with the CALIB ADJ knob. Do not change the GAS SELECTOR ADJUST KNOB.

4. Move the pump switch to ON and observe SAMPLE FLOW RATE indicator in a vertical position. A minimum flow of 1.5 LPM is required. Clean sample line filters (pickup probe filter and elbow filter) if less than 1.5 LPM. If necessary, clean sample-hydrogen mixer. Filters may be blown out with air or cleaned with alcohol and oven dried at 120°F. Sonic cleaned is an acceptable method.

NOTE: A millipore Aerosol Filter, MAWP 037A0 ,on the probe inlet will cut filter maintenance by 90%. A 3/16" tube to 1/8" Tx(nail) reducer, SS-300-R-2, is required to attach filter.

5. Open H_2 tank valve ½ turn and observe the reading on the H_2 tank pressure indicator. Approximately 200 psi of pressure is needed for each hour of operation. Refill H_2 tank prior to using if tank pressure is less than 200 psi.

6. Open H_2 supply valve ½ turn and observe that the reading on the H_2 SUPPLY PRESSURE is 8 psi (or H_2 factory set conditions).

7. Wait two minutes to obtain a hydrogen rich mixture and press IGNITER button. Do not depress for time periods longer than 5 seconds and wait 15 seconds between depressions. There will be a slight "pop" as the hydrogen ignites and meter pointer will move upscale and return to a position upscale of zero. Immediately after ignition, release the IGNITER button.

8. After flame ignition, allow approximately one minute for the chamber to reach operating temperature.

9. Place cover on the instrument and check shoulder strap to make sure if properly snapped in position.

10. The instrument is now ready for use.

VI. Operating Procedure

1. Obtain a Hot Work Permit from the building foreman.

2. Enter the survey area with the instrument ON and flame burning.

3. The probe may be used to measure VCl concentrations inside a poly but do not enter the poly with the entire instrument. A 3/16" I.D. X 10 ft. polypropylene or teflon tubing may be used as an extension hose. The instrument does not have Class I, Group D approval.

4. Take employee exposure readings two feet from equipment hardware and five feet from floor level. The instrument may also be used as a leak detector by placing the probe flush to the equipment.

5. Readings taken on the Probe/Readout Assembly are linear from 1 to 1000 ppm (0.1%) on the ALGC unit when calibrated at 25 ppm. For approximate concentrations in the 0.3 to 10% range when calibrated at 25 ppm, divide all readings by two. A calibration chart is required for each instrument in use. Each new unit placed into service should always have a full calibration over the entire range to determine the linearity of the Probe/Readout Assembly. See the section on calibration.

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6. A portable battery powered Rustrak recorder (0-5 V. input) with shoulder straps may be used with the instrument in non-explosion proof areas. The Style "J" chart makes excellent copy for EPA records on blend tank exhaust at a chart speed of 0.5 inch/minute. Align the instrument readout with the recorder reading by adjusting the recorder potentiometer behind the recorder face plate.

7. If a flameout occurs, return to a non hazardous area, ensure that the pump is running at an air flow rate greater than 1.5 LPM, then press the IGNITER button.

VII. Shutdown Procedure

1. Close H_2 TANK valve. Allow H_2 pressure to go to zero.

2. Close H_2 SUPPLY valve.

3. Move INSTR switch to OFF.

4. Wait 5 seconds and move PUMP switch to OFF.

5. Plug AC battery charger into connector on battery cover.

6. Move the battery charger switch to the ON position. When fully charged, the pointer will be in line with "charged" marker above the scale.

7. When battery is fully charged, move the battery charger switch to OFF and disconnect from the battery connector. Approximately one hour of charging time is required for each hour of operation. However, an overnight charge is recommended since the charger can be left ON indefinitely without damaging the batteries.

8. To install a new battery pack, the instrument panel is removed from the case by unlocking the four (4) $\frac{1}{4}$ turn fasteners on the panel face and also removing the refill cap and elbow connector. The battery pack is removed by taking out the four (4) screws on the panel and disconnecting the power connector at the battery pack.

GENC 000203

VIII. Spot Check Calibration

A weekly calibration check is required using 25 ppm or 100 ppm of vinyl chloride in air compressed gas cylinder (or any monomer to be surveyed). This calibration will align the instrument readout with the previous prepared scale calibration graph.

1. Turn on instrument, air pump, hydrogen flow and ignite flame.
2. Allow the flame to burn for 10 minutes prior to calibrating.
3. Place a hydrogen two-stage regulator on the VCl standard cylinder with a $\frac{1}{4}$ inch O.D. tube on the regulator delivery fitting. Open the cylinder with a quick spurt to blow dust from the cylinder fitting prior to attaching regulator. Close the cylinder valve quickly.
4. Slowly open the gas cylinder valve.
5. Turn the regulator knob until a low level of flow is audible from the flexible tubing.
6. Place sample pickup probe inside flexible tubing. Do not have a sealed system.
7. With the HIGH-LOW switch in the OFF potision, turn the CALIB ADJ knob until the needle on the probe readout assembly points to the exact concentration on the certified gas standard cylinder.
8. Turn the H_2 TANK and H_2 SUPPLY valves OFF.
9. Turn the PUMP switch to the OFF position.
10. With the INSTR switch in the ON position, unlock (counterclockwise) the GAS SELECTOR ADJUST knob and rotate until the needle on the probe readout assembly is on 10 PPM.
11. Lock (clockwise) the GAS SELECTOR ADJUST knob and record the reading on the log sheet. To read the three digit number, read the single number in the "window" (e.g. 4) and then the two digit number on the "dial" (e.g. 76). In this example, the GAS SELECTOR ADJUST reading would be 476.
12. The instrument is ready for use in ambient vinyl chloride surveys (or other monomers when substituted). The above steps may be repeated using 1.0% vinyl chloride in air for blend tank exhaust surveys.

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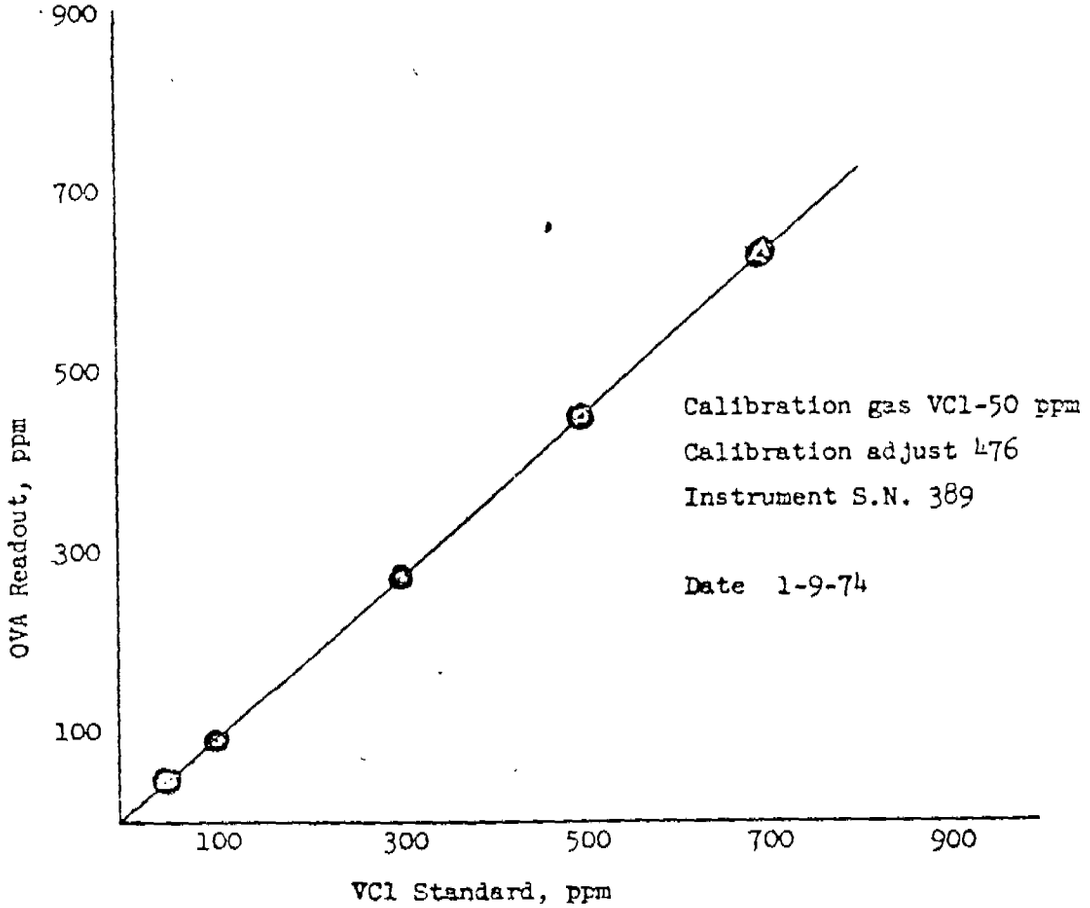
IX. Full Scale Calibration

Each instrument placed in service should immediately be checked for linearity or non-linearity and a graph prepared with the serial number of the instrument recorded on the graph. This graph should be made available to those people interpreting the survey data. A copy of the graph should be inside the instrument case at all times. All data reported on data sheets is considered raw data until corrected by use of this graph.



A reading from this graph indicates that an OVA calibrated with a 50 ppm VCl standard may read 275 for 300 ppm standard gas.

There are various ways to calibrate the OVA scale. Listed below are two methods using certified standards purchased from Precision Gas, New Jersey. A sample calculation for a gas dilution concentration using Method No. 2 is:

17.28 LPM AIR
.09 LPM 1.0% vinyl chloride
17.37 LPM Total Volume

$$ppm = \frac{.09 \text{ LPM} \times .01 \text{ VCl}}{17.37 \text{ LPM Air}} \times 10^6$$

$$ppm = 51.8$$

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X. Method No. 1

1. Follow steps 1 through 11 in the Spot Check Calibration procedure above using 25 or 100 ppm vinyl chloride (or other monomer).

2. Using certified vinyl chloride gas cylinders record the probe readout assembly readings for these approximate values 25, 100 and 500 ppm.

3. Draw graph using these three points on a 0-1000 ppm scale.

4. Use a fourth standard, e.g. 1.0%, and take a reading. If this reading is 2.0%, then the factor to be used for all readings above a 1000 ppm is 0.5. In other words, divide all readings above 1000 ppm by two (2).

5. Record the instrument serial number, GAS SELECTOR ADJUST reading and the standard gas used on the graph.

XI. Method No. 2

1. Follow steps 1 through 11 in the Spot Check Calibration procedure above using 25 or 100 ppm vinyl chloride (or other monomer).

2. Calibrate precision laboratory rotameters (accuracy $\pm$ 0.1 LPM) with air and nitrogen using the bubble tube or wet gas meter method.

   A Bendix Model 8851 Dynamic Flow Calibration unit may be used with or without a vinyl chloride permeation tube.

3. Connect compressed breathing air or charcoal filtered instrument air to the air rotameter and the 1.0% certified vinyl chloride compressed cylinder to the nitrogen rotameter. The outlet flow is manifolded to give a blend of air and vinyl chloride. A restriction is placed in line to maintain a constant stable flow.

4. Make various blends to allow two concentrations in 10-100 ppm range and two in 100-1000 ppm range.

XII. Trouble Shooting Procedure

Follow the guide provided by the attached Table 6-1, Trouble Shooting Procedure. Any problems associated with the hydrogen regulator system should be handled by shipping directly to this factory address.

Century Systems Corporation
Box 133
Arkansas City, Kansas 67005

Phone: 316-447-3811 or 3271

M. D. Rider or M. E. Spe[illegible] may be of assistance in trouble shooting prior to shipping.

GENC 000206

Century Organic Vapor Analyzer
Issue 1

XIII. Recommended Spare Parts

See attached sheet.

XIV. Reference

Operating and Service Manual on Century Portable Organic Vapor Analyzer, Model 98A, Revision A.

GENC 000207

TABLE 6-1

TROUBLE	TROUBLE SHOOTING PROCEDURE	REMEDY
6-1 Low sample flow rate on flow indicator	a) Check particle filter in pickup assembly.	Replace or clean filter if clogged.
	b) Determine assembly containing restriction by process of elimination, i.e., remove probe, remove readout assembly, remove elbow tubing connector and etc.	Investigate the assembly containing the restriction to determine cause of blockage. Clean or replace as required.
	c) If the restriction is in the side pack assembly, further isolate by disconnecting the sample flow tubing at various points, i.e., pump output, chamber input, etc. Note: The inherent restrictions due to length of sample line, flame arrestors, etc., must be taken into account when trouble shooting.	If the restriction is found to be in the detector chamber, remove and clean or replace porous metal flame arrestors. If pump is found to be faulty, remove and clean or replace unit.
6-2 . H_2 flame won't light	a) Check sample flow rate (see 6-1 above).	If sample flow rate is low, follow procedure of 6-1 above.
	b) Check glow plug by removing the chamber exhaust port and observing the glow when the IGNITE button is depressed.	If glow plug does not light up, replace the plug.
	c) Check for rated H_2 Supply Pressure.	If low, adjust to proper level by turning the allen wrench adjustment on the regulator cap.
	d) Check H_2 flow rate by observing the PSI decrease in pressure on the H_2 Tank Pressure gauge. The flow rate should be greater than 150 PSI decrease in pressure per hour. Note: Sufficient time (1 to 2 min.) should be allowed for the H_2 to flow through the capillary to the detector chamber at initial turn-on/	The normal cause for H_2 flow restriction would be a blocked or partially blocked capillary tube. If flow rate is marginally low, attempt to compensate by increasing the H_2 Supply Pressure by one half or one PSI. If flow rate cannot be compensated for, replace capillary tubing.

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TABLE 6-1 (Continued)

TROUBLE	TROUBLE SHOOTING PROCEDURE	REMEDY
6-2 (Continued	e) Check to see if H_2 supply system is frozen up by taking unit into a warm area.	If there is moisture in the H_2 supply system and the unit must be operated in sub-freezing temperatures, purge the H_2 system with dry N_2 and ensure the H_2 gas used is dry.
	f) Disassemble the flame chamber and check for contamination (see Figure 6-2).	If the chamber is dirty, clean with ethyl alcohol and bake dry. If H_2 fuel jet is misaligned, ensure the porous metal flame arrestor is properly seated.
6-3 H_2 flame lights but won't stay lighted.	a) Follow procedures 6-2 (a), (c), (d) and (f) above.	
6-4 Flame out alarm will not go on when H_2 flame is out.	a) Check instrument calibration setting.	The probable cause of the output signal not going low enough to trigger the flame out alarm is current leakage to the collecting electrode due to contamination or moisture in the chamber or electronics housing. Dry chamber out by running unit or purging with dry N_2 or disassemble and clean (see Figure 6-2). If moisture is in the electronics housing replace desicant container (see 6.2.5)
	b) If procedure (a) does not resolve the problem, the probable cause is a malfunction in the preamp assembly.	Return electronics assy to factory for repair.

TABLE 6-1 (Continued)

TROUBLE	TROUBLE SHOOTING PROCEDURE	REMEDY
6-5 Slow response time, i.e., time to obtain response after gas is applied to input.	a) Check to ensure that Probe is firmly seated on the rubber seal in the Readout Assembly	Reseat by holding the probe firmly against the rubber seat and then lock in position with the knurled locking nut.
	b) Check sample flow rate per procedure 6-1 above.	See 6-1 above.
	c) Investigate whether sample input system is leaking by closing off input at the probe and observing the flow rate and sound of the pump. Another method is to blow smoke around the various connections and observe the instrument response.	Through the process of elimination, find the source of the leak and repair.
6-6 Slow recovery time, i.e., too long a time for the reading to get back to ambient after exposure to a high level organic vapor.	a) This problem is normally caused by contamination in the sample input line which absorbs the organic vapor and then has to be pumped for a long period to get the system clean of vapors again. Charcoal in the lines would be the worst type of contamination. Isolate through the process of elimination where the contamination is (see 6-1 (b)).	Clean or replace contaminated sample line or assembly as required.
	b) Check flame chamber for contamination.	Clean as required.
6-7 Ambient background read in clean environment is too high	a) An ambient background reading can be caused by hydrocarbons in the H_2 fuel or fuel supply system. Place finger over sample probe tube restricting sample flow and if meter indication does not go down significantly the contamination is probably in the H_2 fuel.	Use a higher grade of hydrocarbon-free hydrogen. Check for contaminated fittings on filling hose assembly.

GENC 000210

TABLE 6-1 (Continued)

TROUBLE	TROUBLE SHOOTING PROCEDURE	REMEDY
6-7 (Continued)	b) An ambient background reading can also be caused by hydrocarbon contamination in the sample input system. The most likely cause would be a contaminent absorbed or condensed in the sample line.	Clean and/or replace the sample input lines. Normally the lines will clear up with sufficient running.
	c) It should be pointed out that running the instrument tends to keep down the buildup of background vapors. Therefore, run the unit whenever possible and store it with the carrying case open in clean air.	
6-8 Pump will not run	a) Check 1 AMP slow blow fuse on battery pack cover.	Replace fuse. If fuse continues to blow when igniter switch is closed check ignitor for short circuit. If igniter is not the problem there is a short in the wiring or pump motor.
6-9 No power to electronics but pump runs.	a) Check 1/4 AMP fuse on top of battery pack.	Replace fuse. If fuse continues to blow there is a short in the electronics assembly.
6-10 No power to pump or electronics	a) Place battery on charger and see if power is then available.	If power is available battery pack is dead or open.

CENTURY SYSTEMS CORPORATION

P.O. BOX 133 ARKANSAS CITY, KANSAS 67005
TELEPHONE 316 447-3311 or 447-3271

PRICE LIST FOR OVA-98 SPARES

520000-1

Effective Date - Dec. 1, 1973

Part No.	Description	Price
510027-1	Igniter	$ 2.00
510030-2	Readout Assembly	105.00
510035-2	Probe Assembly	25.00
510040-2	Funnel Sampler Assembly	6.50
510045-1	A.C. Battery Charger Assembly	95.00
510052-1	Shield (Switchguard)	.95
510055-1	Cylinder Assembly	135.00
510060-2	Pump Assembly	39.40
510063-1	Pump Diaphragm	2.00
510070-1	Battery Pack Assembly	75.00
510073-1	Capillary Tube Assembly	7.50
510075-2	Flow Indicator Assembly	19.50
510080-1	Case Assembly (Side Pack)	30.00
510085-1	Hydrogen Filling Assembly	60.00
510090-1	Instrument Carrying Case Assembly	60.00
510094-1	Carrying Strap Assembly (Shoulder Strap)	9.75
510100-1	H.P. Regulator Assembly	35.00
510100-2	L.P. Regulator Assembly	35.00
510113-1	Motor Assembly (Mod)	70.00
510116-1	Replaceable Porous Metal Filters	5.00/pkg. (10
510125-1	Close Area Sampler Assembly	4.75
510126-1	Tubular Sampler Assembly	4.75

PRICE LIST FOR OVA-98 SPARES
(Cont'd.)

Part No.	Description	Price
510250-1	Mixer/Burner Assembly	$ 23.10
	Mixer/Burner Assembly (Rebuilt with exchange)	8.10
510250-2	Mixer/Burner Assembly (with stainless steel filters)	23.10
510254-1	Handle Assembly	8.50
510301-1	Eccentric Assembly	7.95
510319-2	Exhaust Port Assembly (with stainless steel flame arrestor)	5.00
[redacted]0251-2	Elbow Connector Assembly	4.95
250S	Meter Movement	35.00
MDL-1	Slo-Blo fuse, 1 amp.	.40
AGC-1/4	Standard fuse	.15
1/4 Amp	Littlefuse Microfuse	1.25
	Teflon Tubing	1.00/ft.

Prices are f.o.b. Arkansas City, Kansas, and are subject to change without notice. Shipping will be by Parcel Post or United Parcel Service unless otherwise instructed. Prices are valid for use in continental U.S.A. only.