FRUITS & Associates, Inc

HIGH-VAC REMEDIATION

Fruits and Associates, Inc is pleased to introduce our High-Vacuum Remediation (HVR) service developed solely for performing Mobile Enhanced Multi-Phase (MEME) events. The equipment is completely mobile and is constructed with safety as our first concern. The system was developed using NEMA 7 (explosion proof) guidelines and the entire process is monitored and controlled by an onboard Programmable Link Computer (PLC). All process controls include additional fail safe switches, with redundancy switches installed at critical operating points. The extraction process is performed using a 30 horsepower - variable speed - rotary lobe compressor, which is capable of 25" of mercury. Up to four extraction wells can be connected simultaneously providing individual extraction well flow rates. The off-gas destruction is accomplished in our 7 million BTU/hr Thermal Oxidizer (THOX) unit. This unit provides a hydrocarbon destruction rate of approximately 50-75 gallons per hour. All MEME events, even if not required, include off-gas destruction of the extracted vapors. The entire process is fueled by liquid propane which further provides an environmentally clean and emission free system. During the extraction process, a total of 3,000 gallons of groundwater can be stored on board for later disposal. During the initial 8-hour event, if all operating conditions are within the state guidelines, the system can continue to operate in unattended mode for up to an additional 16 hours. The system will safely shut down if during this extended event the operating conditions change.

Technology

A MEME event involves the extraction of subsurface vapors and liquids from a monitoring well or recovery well in order to remove the phase separated hydrocarbon (PSH) associated with a product release. This is accomplished by applying high levels of vacuum pressure and flow to the extraction point. To eliminate mounding of the water table, a drop tube (commonly known as a stinger) is initially inserted in the well at the static water level depth. The applied vacuum and airflow extracted from the well is pulled through this drop tube. As the water table attempts to mound due to the application of vacuum, the liquids are "slurped" through this drop tube along with the air flow. This slurping effectively maintains the static conditions of the water table while the elevated vacuum is applied to the well during the event. This method of pumping liquids with air is more commonly called an air lift pump. In order to minimize any changes to the smear zone associated with the seasonal fluctuation of the water table, the drop tube is lowered to the maximum historical water level demonstrated for this extraction point. This draw down (one to five feet) below the static water level, depresses the water level in the well and creates a cone of influence. This influence maximizes the available well slot exposed to the vadose zone and allows any PSH to flow back to the extraction well(s).

In order to maximize fluid recovery from the extraction point, fresh air is introduced at the well surface. This additional fresh air (5-25 CFM) is measured with an airflow gauge mounted to the inlet valve at the well head. The fresh air flow rate measurement is later deducted from the total flow associated with the extraction process from the well, resulting in an accurate flow rate derived from the vadose zone. Additionally, two vacuum gauges are installed; one on the stinger assembly and one on the well casing to determine the amount of applied vacuum. The extraction well setup and piping configuration is shown in Figure #1.

During the extraction process, the combined air and liquids are transferred to the HVR mobile treatment system. The liquids are separated from the airflow with a liquid scrubber/ knock-out system and discharged into an internal storage tank for later disposal. The hydrocarbon vapors are transferred to the off-gas treatment system and are incinerated in our forced air THOX unit at 1500 degrees. After thorough destruction of the contaminants in the air stream, the clean air is discharged into the atmosphere. A complete flow diagram of this process is shown in Figure #2.

Calculations

During the MEME event, measurements are taken of both the influent and effluent flow rates, the concentrations of the vapors removed (before off-gas treatment), as well as the off gas treatment system concentrations. These measurements are used to calculate the mass removal rates and the off-gas emission rates. The extraction flow rates are measured using a Dwyer DS-300 averaging Pitot tube attached to a differential pressure gauge. A separate flow rate is calculated for each influent well (if more than one well is connected). In order to achieve maximum destruction of the hydrocarbon vapors, additional quench air (500-2,000 CFM) is added to the vapor stream just before entering the THOX unit. A separate Pitot tube and differential gauge is installed at the THOX unit inlet and is used to measure the THOX unit's flow rate.

In order to accurately calculate the mass removal rates associated with the MEME event, influent concentration measurements are taken using a TVA-1000 Flame Ionization Detector (FID) instrument calibrated to methane. This FID instrument has a dynamic range of 0-50,000 PPM as methane, 0-100,000 PPM as hydrocarbon. Our concentration samples are collected before any additional bleed or quench air is added to the extracted flow rate. These undiluted concentration measurements exceed the dynamic range of any FID instrument. In order to accurately record the high concentrations observed during a MEME event, a calibrated 10:1 dilution valve is used to cut the sample. This dilution valve, along with the FID instrument, is calibrated before the start of each event.

In order to eliminate the naturally occurring methane that is present during a typical MEME event, each thirty-minute concentration sample is measured twice. The first sample is collected directly from the system, and recorded as the total VOC concentration. The second sample is collected using an in-line activated carbon filter to eliminate the hydrocarbon compounds and is recorded as methane only results. These methane only results are then subtracted from the total VOC concentration measurements, resulting in a Non Methane Organic Compound (NMOC) concentration. As with any field instrument calibrated to methane, the NMOC results are recorded as parts per million by volume (PPMv) as if the concentrations were methane. A conversion is then necessary to calculate an accurate mass removal rate. Using the NMOC total and the TVA-1000's factory certified response ratio for hydrocarbons, the NMOC results are converted to equivalent hydrocarbon mg/L's. A TVA-1000 FID has an average response ratio of 600 PPM per mg/L of unleaded gasoline and 200 PPM per mg/L of diesel. Summaries of these calculations are shown in figure #3.

Report

During the event, all of the operating data is collected and entered into the onboard computer system. This system processes this information and calculates the mass removal and system flow rates. The operating information is then used by the system operator to further enhance the system's performance. Once the event is complete, this data is used to develop a detailed 16 page MEME report. For comparison purposes, the mass removal rates are calculated as pounds of carbon, pounds of hydrocarbon, pounds of methane, and equivalent gallons.

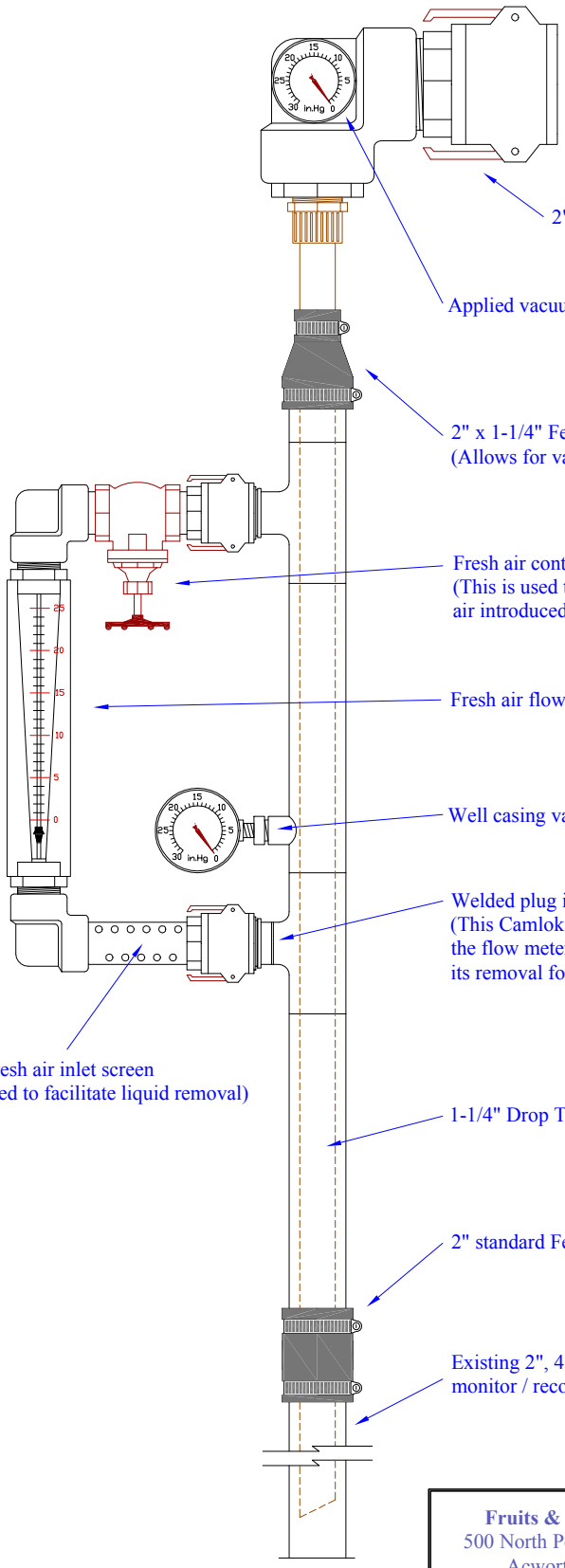
During the MEME event, the following operating measurements are also observed:

- Influent temperature is measured in order to determine the amount of suspended liquid associated with the vapor stream. A psychometric chart is used to determine the Dry Standard Cubic Feet per Minute (DSCFM).

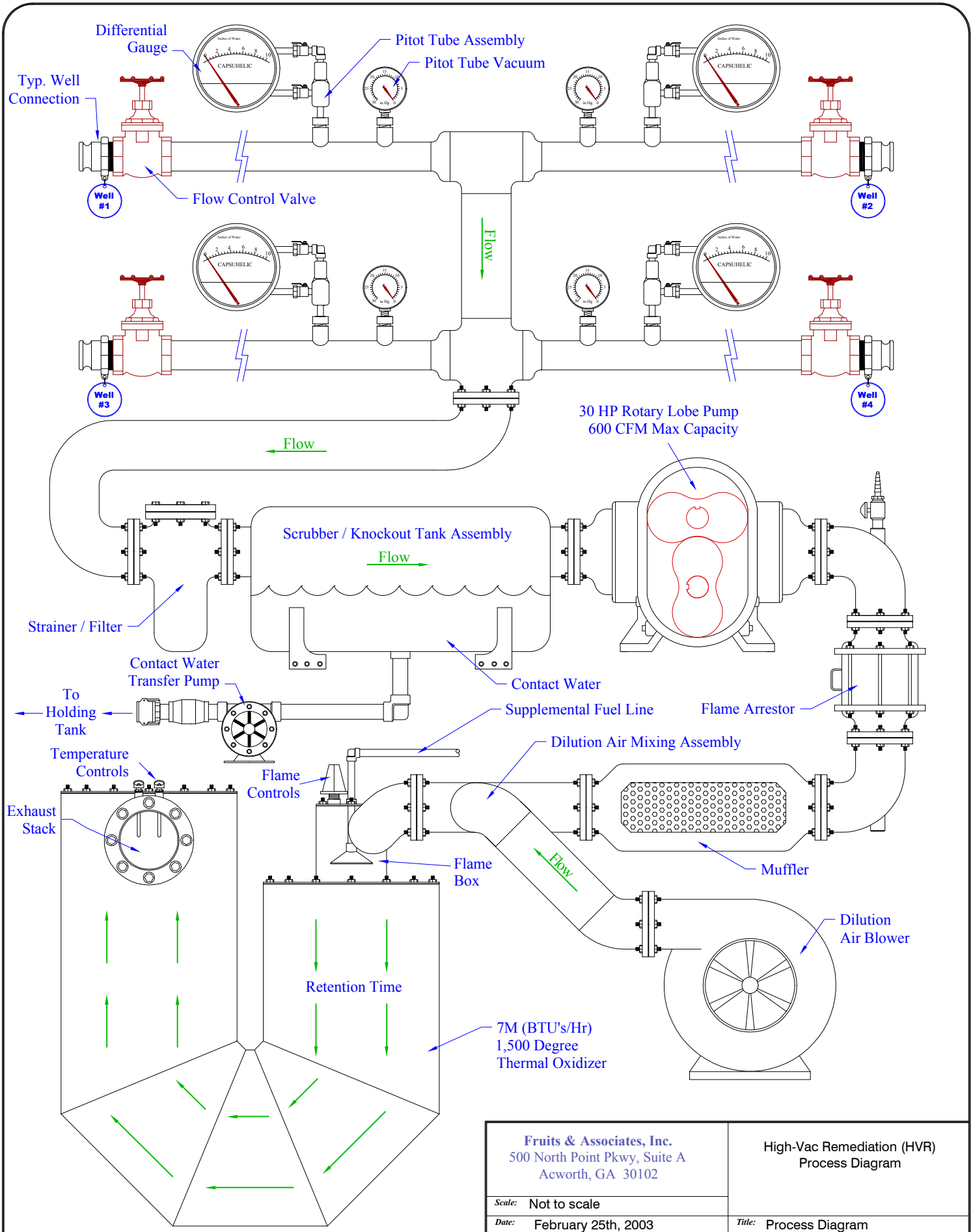
- Using an oil/water interface probe, a complete round of water level measurements are recorded at the associated monitoring wells prior, during, and after the MEME event is complete.

- Using a digital manometer, vacuum measurements (in inches of water column) are measured at the adjacent monitoring wells during the event to determine the maximum radius of vacuum influence.

- Off-gas emission (effluent) concentrations are measured at the THOX unit discharge stack and are analyzed using the TVA-1000. These results are used to calculate the total mass discharged to the atmosphere.



Fruits & Associates, Inc. 500 North Point Pkwy, Suite A Acworth, GA 30102	High-Vac Remediation (HVR) Well Manifold Assembly (Stinger Assembly)
Scale: Not to scale	
Date: February 25th, 2003	*Title:* Well Connection Diagram
Drawing By: John M. Fruits	*Checked By:* John M. Fruits
	Figure #: 1



Fruits & Associates, Inc. 500 North Point Pkwy, Suite A Acworth, GA 30102	High-Vac Remediation (HVR) Process Diagram
Scale: Not to scale	
Date: February 25th, 2003	*Title:* Process Diagram
Drawing By: John M. Fruits	*Checked By:* John M. Fruits
	Figure #: 2

Calculation of Hydrocarbon Loading Rate

Formula:

$$\dot{m} = Q \times C \times CF$$

Where:

$\dot{m}$ = Contaminant Loading Rate (lbs/hr)

Q = Air Flow Rate (CFM)

C = Contaminant Concentration (mg/m^3)

CF = Conversion Factor = 0.000003743 = $\frac{1\ m^3}{35.31\ ft^3}$ **X** $\frac{1\ lb}{454 \times 10^3\ mg}$ **X** $\frac{60\ min}{1\ hr}$

Since all field measurements are in PPM_V, the following formula is used to convert to mg/m^3.

$$C = \frac{PPM_V}{R} \times \frac{1{,}000\ L}{1 m^3}$$

Where:

R = TVA Response Ratio*

*According to the manufacture's documentation, *The Foxboro Monitor, Volume 3, Issue 1A, Page 5, Response Ratio of Fuel Samples,* the Foxboro TVA-1000 has a response ratio of approximately $\frac{600\ PPM_V}{1\ mg/L}$ for Gasoline, $\frac{200\ PPM_V}{1\ mg/L}$ for Diesel Fuel.

Example:

Q = Air Flow Rate = 200 CFM

C = TVA-1000 Reading = 20,400 PPM_V

R = Response Ratio for Gasoline = 600

Results:

$$25.45\ lbs/hr = 200 \times \left(\frac{20{,}400}{600} \times 1{,}000\right) \times 0.000003743$$

($\dot{m}$ = 25.45 lbs/hr; Q = 200; C = 20,400; R = 600; CF = 0.000003743)

Note:

To convert *lbs* to equivalent gallons, the following formula is used:
Specific Gravity (Gasoline =0.74, Diesel = 0.84) x Conversion Factor (8.333) = *lbs/gal.*
(Gasoline = 6.16 *lbs/gal.* Diesel = 6.99 *lbs/gal.)*

Fruits & Associates, Inc. 500 North Point Pkwy, Suite A Acworth, GA 30102	High-Vac Remediation (HVR) Concentration Calculations
Scale: Not to scale	
Date: February 25th, 2003	*Title:* Concentration Calculations
Drawing By: John M. Fruits	*Checked By:* John M. Fruits
	Figure #: 3