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7. Abstract

Tank 241-TY-103 headspace gas and vapor samples were collected and analyzed to help determine the potential risks to tank farm workers due to fugitive emissions from the tank. The drivers and objectives of waste tank headspace sampling and analysis are discussed in "Program Plan for the Resolution of Tank Vapor Issues" (Osborne and Huckaby 1994). Tank 241-TY-103 was vapor sampled in accordance with "Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution (Osborne et al., 1994).

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Tank 241-TY-103 Vapor Sampling and Analysis Tank Characterization Report

X.0 INTRODUCTION

Tank TY-103 headspace gas and vapor samples were collected and analyzed to help determine the potential risks of fugitive emissions to tank farm workers. The drivers and objectives of waste tank headspace sampling and analysis are discussed in *Program Plan for the Resolution of Tank Vapor Issues* (Osborne and Huckaby 1994). The tank TY-103 headspace was sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1994).

X.1 SAMPLING EVENT

Headspace gas and vapor samples were collected from tank TY-103 using the vapor sampling system (VSS) on April 11, 1995 by WHC Sampling and Mobile Laboratories (WHC 1995). Sample collection and analysis were performed as directed by *Tank 241-TY-103 Tank Characterization Plan* (Homi 1995). The tank headspace temperature was determined to be 15.9 °C. Air from the tank TY-103 headspace was withdrawn from a single elevation via a 5.5-m long heated sampling probe mounted in riser 8, and transferred via heated tubing to the VSS sampling manifold. All heated zones of the VSS were maintained at approximately 40 °C. All tank air samples were collected between 10:37 a.m. and 2:09 p.m., with no sampling anomalies noted.

Sampling media were prepared and analyzed by WHC, Oak Ridge National Laboratories (ORNL), and Pacific Northwest Laboratories (PNL). The 40 tank air samples and 2 ambient air control samples collected are listed in Table X-1 by analytical laboratory. Table X-1 also lists the 14 trip blanks and 14 field blanks provided by the laboratories.

A general description of vapor sampling and sample analysis methods is given by Huckaby (1995). The sampling equipment, sample collection sequence, sorbent trap sample air flow rates and flow times, chain of custody information, and a discussion of the sampling event itself are given in WHC 1995 and references therein.

X.2 INORGANIC GASES AND VAPORS

Analytical results of sorbent trap and SUMMA^{TM,1} canister tank air samples for selected inorganic gases and vapors are given in Table X-2 in parts per

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[1] SUMMA is a trademark of Molectrics, Inc., Cleveland, Ohio.

million by volume (ppmv). Inorganic analyte sorbent traps and SUMMA^{TM} canisters were prepared and analyzed by PNL (Ligotke et al. 1995).

X.2.1 Ammonia, Hydrogen, and Nitrous Oxide

The reported ammonia concentration, 49 ppmv, is about 2 times the National Institute of Occupational Safety and Health (NIOSH) 8-hr recommended exposure limit (REL) of 25 ppmv for ammonia (NIOSH 1995). Ammonia has been observed in virtually all of the passively ventilated waste tanks sampled to date, at concentrations ranging from about 3 ppmv in tank C-108 (Lucke et al. 1995), to 1040 ppmv in BY-108 (McVeety et al. 1995).

The concentration of hydrogen in tank TY-103 was determined to be < 93 ppmv. Hydrogen in the waste tanks is of concern as a fuel. Given that the lower flammability limit (LFL) for hydrogen in air is about 4 % by volume, a 93 ppmv hydrogen concentration in tank TY-103 would correspond to about 0.23 % of its LFL. At this level, hydrogen is not a flammability concern in tank TY-103.

The reported nitrous oxide concentration in tank TY-103, 159 ppmv, is typical of other waste tanks sampled to date. This concentration is over 6 times the NIOSH 8-hr REL of 25 ppmv for nitrous oxide (NIOSH 1995). Nitrous oxide, also known as laughing gas, has been detected in other passively ventilated waste tanks at average concentrations as low as about 12 ppmv in tank TX-105 (Klinger 1995), and as high as 763 ppmv in tank C-103 (Huckaby and Story 1994).

X.2.2 Carbon Monoxide and Carbon Dioxide

Carbon monoxide in the tank TY-103 headspace, characterized as < 12 ppmv, is below the NIOSH 8-hr REL of 35 ppmv for carbon monoxide. In ambient air it typically ranges from 0.05 to 0.15 ppmv. Because different analytical methods have been used to measure carbon monoxide in the waste tanks sampled to date, the information on carbon monoxide has varied from tank to tank. However, elevated waste tank headspace carbon monoxide concentrations are common, and are thought to be due to the decomposition of organic waste in the tanks. Carbon monoxide has not been measured at very high levels in any of the waste tanks. The highest level measured to date was 26.7 ppmv in tank C-103 (Huckaby and Story 1994).

The carbon dioxide concentration in the tank TY-103 headspace, measured at an average 121 ppmv, is significantly lower than it is in ambient air. Carbon dioxide is normally present in the ambient air at a concentration of 350 to 400 ppmv, and is typically lower than ambient in the waste tank headspaces. The 2 ambient air samples collected at the start of the tank TY-103 gas and vapor sampling event, for example, were measured to have an average 356 ppmv of carbon dioxide. Carbon dioxide introduced by air exchange with the atmosphere is readily absorbed by caustic supernatant and interstitial liquids of the waste tanks, and converted to carbonate in solution. The 121 ppmv of carbon dioxide in the tank TY-103 headspace is typical of values for the waste tanks sampled to date.

X.2.3 Nitric Oxide, Nitrogen Dioxide, Water and Tritium

Nitric oxide and nitrogen dioxide concentrations in the tank TY-103 headspace were determined to be 0.10 ppmv and ≤ 0.02 ppmv, respectively. These are acid gases that would have very low equilibrium concentrations above the high pH sludge in tank TY-103. The measurable presence of nitric oxide is not uncommon in the waste tank headspaces, and may be due to its formation from oxygen and nitrogen in the radiation field of the headspace. The NIOSH 8-hr REL is 25 ppmv for nitric oxide, and the 15-minute short term exposure limit (STEL) for nitrogen dioxide is 1 ppmv.

The water vapor concentration of tank TY-103 was determined to be about 11.6 mg/L, at the measured tank headspace temperature of 15.9 °C and pressure of 994.3 mbar (745.9 torr), (WHC 1995). This corresponds to a water vapor partial pressure of 15.4 mbar (11.6 torr), to a dew point of 13.5 °C, and to a relative humidity of 85 %.

Silica gel sorbent traps were used to sample for tritium. It is assumed that tritium produced by the waste combines with hydroxide ions to form tritium-substituted water. Evaporation of the tritium-substituted water would then result in airborne radioactive contamination. Silica gel sorbent traps adsorb virtually all (normal and tritium-substituted) water vapor from the sampled tank air, and are analyzed at the WHC 222-S laboratory. Radiochemical analysis of the silica gel trap indicated the total activity of the headspace to be less than 50 pCi/L (WHC 1995).

X.2.4 Discussion of Inorganic Gases and Vapors

Aside from water vapor, the most abundant waste constituents in the tank TY-103 headspace are nitrous oxide and ammonia. These have been detected in most tank headspaces sampled to date and, along with hydrogen, are usually the dominate waste species. The concentrations of ammonia and nitrous oxide are typical of other waste tanks that have been sampled.

The relative standard deviations of the inorganic gas and vapor results given in the last column in Table X-2 are satisfactory for the methods used. Relative standard deviations range from 1.1 % for water vapor to about 23 % for nitrous oxide results. Because the precision reported depends both on sampling parameters (e.g., sample flow rate and flow time for sorbent traps) and analytical parameters (e.g., sample preparation, dilutions, etc.), small relative standard deviations suggest proper control was maintained both in the field and in the laboratories.

X.3 ORGANIC VAPORS

Organic vapors in the tank TY-103 headspace were sampled using SUMMA^{TM} canisters, which were analyzed by PNL, and triple sorbent traps (TSTs), which were analyzed by ORNL. Gas chromatography (GC) and mass spectroscopy (MS) were used by PNL and ORNL to separate, identify, and quantitate the analytes.

Descriptions of sample device cleaning, sample preparations, and analyses are given by Jenkins et al. (1995) and Ligotke et al. (1995).

SUMMA^{TM} sample results should be considered to be the primary organic vapor data for tank TY-103. ORNL analyses of TST samples from this and other waste tanks generally agree with, support, and augment the SUMMA^{TM} sample results. However, because certain WHC quality assurance requirements were not satisfied by ORNL, the quality assurance assessment of ORNL by Hendrickson (1995) should be reviewed before results unique to the TST samples are used for decision making.

X.3.1 Positively Identified Organic Compounds

Positive identification of organic analytes using the methods employed by PNL and ORNL involves matching the GC retention times and MS data from a sample with that obtained by analysis of standards. The concentration of an analyte in the sample is said to be quantitatively measured if the response of the GC/MS has been established at several known concentrations of that analyte (i.e., the GC/MS has been calibrated for that analyte), and the MS response to the analyte in the sample is between the lowest and highest responses to the known concentrations (i.e., the analyte is within the calibration range).

ORNL and PNL were assigned different lists of organic compounds, or target analytes, to positively identify and measure quantitatively. The ORNL target analyte list was derived from a review of the tank C-103 headspace constituents by a panel of toxicology experts (Mahlum et al. 1994). The PNL target analyte list included 39 compounds in the Environmental Protection Agency (EPA) task order 14 (TO-14) method, which are primarily halocarbons and common industrial solvents (EPA 1988), plus 14 analytes selected mainly from the toxicology panel's review of tank C-103.

Table X-3 lists the organic compounds positively identified and quantitated in SUMMA^{TM} samples. SUMMA^{TM} analyses were performed according to the TO-14 methodology, except for methane analysis, which was analyzed with the inorganic gases (Ligotke et al. 1995). Only 6 of the 39 TO-14 target analytes (trichlorofluoromethane, 1,1,2-trichloro-1,2,2-trifluoroethane, trichloromethane, tetrachloromethane, toluene, and tetrachloromethane) and only 10 of the 14 additional target analytes were measured to be above the 0.005 ppmv detection limit of the analyses. Averages reported are from analyses of 3 SUMMA^{TM} canister samples.

Jenkins et al. (1995) report the positive identification of 24 of 27 target analytes in TST samples. Dichloromethane, dibutyl butylphosphonate, and tributyl phosphate were the only TST target analytes not detected. The average concentrations of the detected target analytes, from the analysis of 4 TSTs, are given in Table X-4. Despite calibration of the instrument over about a 20-fold concentration range, 21 of the 24 compounds listed in Table X-4 were outside of the calibration range in at least 2 of the TST samples.

Both PNL and ORNL report target analyte concentrations in ppmv of analyte in dry air. To correct for the measured water vapor content of tank TY-103 and obtain concentration in ppmv of analyte in moist tank air, multiply the dry-air ppmv concentrations by 0.985.

Eleven target analytes were common to both TST and SUMMA™ analyses. Table X-5 lists these, and their reported average concentrations in TST and SUMMA™ samples. Results from these 2 sampling and analytical methods are in fairly good agreement. As indicated in Table X-5, the reported concentrations of acetone and n-hexane were significantly higher in SUMMA™ samples than in TST samples. The target analytes are generally only present at very low concentrations, however, and none are near levels of concern. Benzene, propanenitrile, and acetonitrile have the lowest NIOSH RELs of the 11 compounds in Table X-5, being 0.1, 6, and 20 ppmv, respectively.

n-Tridecane is the only analyte in either Tables X-3 or X-4 to be measured above 1 ppmv. At the reported concentrations, the target analytes do not individually or collectively represent a flammability hazard.

X.3.2 Tentatively Identified Organic Compounds

In addition to the target analytes, the ORNL and PNL analytical procedures allow the tentative identification of other organic compounds. Tentative identification of analytes was performed by comparing the MS molecular fragmentation patterns with a library of known MS fragmentation patterns. This method allows an organic analyte to be identified (with reasonable certainty) as an alkane, a ketone, an aldehyde, etc., and may also determine its molecular weight. The method usually does not, however, allow the unambiguous identification of structural isomers, and this ambiguity increases with analyte molecular weight. Many analytes can be tentatively identified with reasonable confidence without having to inject standards of each into the GC/MS to determine their GC retention times or specific MS patterns.

By the nature of the sampling devices, virtually all organic vapors present in the tank headspace are collected by both TST and SUMMA™ samples. Analyses of the samples are designed to recover, separate, and identify the organic vapors in the samples. TSTs are not good for collecting highly volatile compounds (i.e., molecules more volatile than propane), but are quite good for most others. In contrast, the recovery of very low volatility compounds (i.e., molecules with more than about 15 carbon atoms) and some polar compounds with moderate volatility (i.e., butanal) from SUMMA™ samples has been problematic.

The tentatively identified compounds recovered from SUMMA™ samples, in the order by which the eluted chromatographically, are given in Table X-6 with estimated concentrations. Only non-zero results are included in the reported averages. The list of tentatively identified compounds detected in TST samples, and their estimated concentrations, is given in Table X-7. Compounds are listed in Table X-7 according to the order by which the eluted chromatographically. The averages reported by ORNL in Table X-7 are all 4-sample averages, and if an analyte was not detected in a sample, its concentration in that sample was considered to be zero for averaging purposes. Estimated concentrations are in mg/m^3, based on dry air at 0 °C and 1.01 bar.

The ORNL and PNL methods used to tentatively identify and estimate concentrations are described by Jenkins et al. (1995) and Ligotke et al. (1995), respectively, and should be reviewed before this data is used for decision making. Concentrations given in Tables X-6 and X-7 should be considered rough estimates.

X.3.4 Discussion of Organic Compounds

The organic compounds listed in Tables X-3 through X-7 may be classified as either 1) organic compounds added to tank TY-103 as waste that are still evaporating, or 2) organic compounds that have been generated by reactions of the original waste.

The first category encompasses all organic compounds that were placed into the tank as waste. It includes the semivolatile straight-chain alkanes, which were used as diluents of tributyl phosphate in various plutonium extraction processes. These alkanes (i.e., n-undecane, n-dodecane, n-tridecane, n-tetradecane, and n-pentadecane) are often referred to in Hanford site literature as the normal paraffinic hydrocarbons (NPHs). About 90 % of the total estimated organic vapor in tank TY-103 TST samples is due to n-dodecane, n-tridecane, and n-tetradecane. The same 3 compounds account for about 82 % of the total estimated organic vapor concentration in SUMMA^{TM} samples.

The tentatively identified cyclosiloxanes (i.e., Cmpd # 9 and 11 in Table X-7) may also have been sent to tank TY-103 with other wastes. Small quantities of organo-silicon compounds may have been introduced to the waste tank through their use as defoaming agents, but they may also be present in the headspace due to their use in liquid traps at the tank's breather riser. These have been observed in TST blanks, however, and they may be present as artifacts of the gas chromatography process.

The absence of tributyl phosphate in the tank TY-103 samples does not necessarily indicate it is not present in the headspace or the waste. The relatively high concentrations of the tributyl phosphate diluents (i.e., n-dodecane, n-tridecane, and n-tetradecane) and their degradation products is reason to expect tributyl phosphate may be present in the tank waste. 1-Butanol, which is one of the most abundant organic compounds identified in tank TY-103 TST samples, is known to be a product of the hydrolysis of tributyl phosphate. Furthermore, informal tests by ORNL indicate that tributyl phosphate is adsorbed by the glass fiber filters used during sampling to protect the samples from radiolytic particulate contamination. Based on these considerations, the lack of tributyl phosphate in the tank TY-103 headspace samples should not be taken as proof it is not present in the headspace or the waste.

A relatively large number of halogenated organic compounds were detected in samples from tank TY-103, including trichlorofluoromethane (which is frequently detected in the waste tanks), trichloromethane, tetrachloromethane, 1,1,2-trichloro-1,2,2-trifluoroethane, and tetrachloroethene. These compounds are frequently used as cleaning solvents and may have been sent to the waste tanks when they became radiologically contaminated.

The second category includes all organic compounds that have been generated via radiolytic and chemical reactions of the waste. The majority of compounds listed in Tables X-3 through X-7 fall into this category, including the alcohols, aldehydes, alkenes, ketones, nitriles, and volatile alkanes, all of which have been associated with the degradation of the NPHs.

The total organic vapor concentration of tank TY-103 was estimated by Jenkins et al. to be about 60 mg/m^3 from the analysis of 4 TST samples by GC/MS. A similar summation of organic compounds measured in SUMMA^{TM} samples from tank TY-103 provides an estimated total organic vapor concentration of 31.8 mg/m^3. Though these estimated total organic vapor concentrations are not completely equivalent to the total nonmethane organic compound (TNMOC) concentration obtained using the EPA task order 12 (TO-12) method (EPA 1988), they are comparable. TNMOC measurements of other waste tanks have ranged from as high as about 5,000 mg/m^3 in tank C-103 (Rasmussen and Einfeld 1994), to as low as 0.18 mg/m^3 in tank C-111 (Rasmussen 1994), while the TNMOC concentration of clean ambient air ranges from about 0.03 to 0.1 mg/m^3. Compared to other waste tanks that have been sampled, tank TY-103 has a relatively high concentration of organic vapors.

In summary, the organic vapors in tank TY-103 clearly indicate the presence of the semivolatile NPHs and their degradation products in the tank waste. Tributyl phosphate was not detected in any of the headspace samples, but there is strong evidence that it is also present in the waste.

Table X-1
Tank TY-103 Gas and Vapor Sample Type and Number

Laboratory	Sampling Device	Nominal Sample Volume (L)	Target Analytes	Number of Samples
Oak Ridge National Laboratories	Triple Sorbent Trap	0.2, 1.0, and 4.0	Organic vapors	12 tank air samples, + 2 trip blanks + 2 field blanks
Pacific Northwest Laboratories	Acidified Carbon Sorbent Trap	3.0	Ammonia	6 tank air samples + 3 trip blank + 3 field blanks
	Triethanolamine Sorbent Trap	3.0	Nitrogen Dioxide	6 tank air samples + 3 trip blank + 3 field blanks
	Oxidation Bed + Triethanolamine Sorbent Trap	3.0	Nitric Oxide	6 tank air samples + 3 trip blank + 3 field blanks
	Silica Gel Sorbent Trap	3.0	Water vapor	6 tank air samples + 3 trip blanks + 3 field blanks
	SUMMA^{TM} canister	6.0	Carbon Dioxide, Carbon Monoxide, Hydrogen, Methane, Nitrous Oxide, Organic vapors	3 tank air samples + 2 ambient air samples
WHC 222-S Laboratory	Silica Gel Sorbent Trap	1.0	Tritium-Substituted Water Vapor	1 tank air sample

Table X-2
Tank TY-103 Inorganic Gas and Vapor Concentrations

Compound	CAS[1] number	Sample Type	Number of samples	Average (ppmv)	Standard Deviation (ppmv)	RSD[2] (%)
Ammonia, NH_3	7664-41-7	Sorbent Trap	6	49	1	2
Carbon Dioxide, CO_2	124-38-9	SUMMA^{TM}	3	121	7	6
Carbon Monoxide, CO	630-08-0	SUMMA^{TM}	3	< 12	--	--
Hydrogen, H_2	1333-74-0	SUMMA^{TM}	3	< 93	--	--
Nitric Oxide, NO	10102-43-9	Sorbent Trap	6	0.10	0.02	20
Nitrogen Dioxide, NO_2	10102-44-0	Sorbent Trap	6	≤ 0.06	--	--
Nitrous Oxide, N_2O	10024-97-2	SUMMA^{TM}	3	159	37	23
Water Vapor, H_2O	7732-18-5	Sorbent Trap	6	15,500 (11.6 mg/L)	200 (0.1 mg/L)	1.1

1. CAS = Chemical Abstracts Service.

2. RSD = relative standard deviation.

Table X-3
Tank TY-103 Positively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS[1] Number	Average (ppmv)	Standard Deviation (ppmv)	RSD[2] (%)
1	Ethanenitrile (acetonitrile)	75-05-8	0.075	0.003	4
2	Propanone (acetone)	67-64-1	0.13	0.01	7
3	Trichlorofluoromethane	75-69-4	0.14	0.01	8
4	1,1,2-trichloro-1,2,2-trifluoroethane	76-13-1	0.007	0.001	8
5	Propanenitrile	107-12-0	0.017	0.006	36
6	1-Propanol	71-23-8	0.023	0.007	30
7	2-Butanone	78-93-3	0.017	0.007	39
8	n-Hexane	110-54-3	0.38	0.02	4
9	Trichloromethane (chloroform)	67-66-3	0.008	0.0002	2
10	Tetrahydrofuran	109-99-9	0.022	0.001	4
11	Tetrachloromethane (carbon tetrachloride)	56-23-5	0.029	0.002	6
12	n-Heptane	142-82-5	0.006	0.0004	7
13	Pyridine	110-86-1	0.012	0.008	67
14	Toluene	108-88-3	0.013	0.001	5
15	Tetrachloroethene	127-18-4	0.010	0.0004	4
16	n-Decane	124-18-5	0.006	< 0.01	--
17	Methane	74-82-8	< 12	--	--
Sum of positively identified compounds:			3.52	mg/m^3	

1. CAS = Chemical Abstract Service.

2. RSD = relative standard deviation.

Table X-4
Tank TY-103 Positively Identified Organic Compounds in TST Samples

Cmpd #	Compound	CAS[1] Number	Average (ppmv)	Standard Deviation (ppmv)	RSD[2] (%)
1	Ethanenitrile[3] (acetonitrile)	75-05-8	0.040	0.015	38
2	Propanone[3] (acetone)	67-64-1	0.042	0.010	23
3	1,1-Dichloroethene[3] (vinylidene chloride)	75-35-4	0.0032	0.0021	67
4	Propanenitrile[3]	107-12-0	0.0088	0.0013	15
5	Butanal	123-72-8	0.035	0.006	18
6	n-Hexane[3]	110-54-3	0.0081	0.0011	14
7	Benzene[3]	71-43-2	0.0047	0.0016	33
8	1-Butanol	71-36-3	0.15	0.04	25
9	Butanenitrile[3]	109-74-0	0.012	0.003	24
10	2-Pentanone[3]	107-87-9	0.0047	0.0008	17
11	n-Heptane[3]	142-82-5	0.0065	0.0008	13
12	Toluene[3]	108-88-3	0.011	0.002	17
13	Pentanenitrile[3]	110-59-8	0.0075	0.0008	10
14	2-Hexanone[3]	591-78-6	0.0038	0.0007	19
15	n-Octane[3]	111-65-9	0.0047	0.0007	15
16	Hexanenitrile[3]	628-73-9	0.0061	0.0007	12
17	2-Heptanone[3]	110-43-0	0.0034	0.0007	20
18	n-Nonane[3]	111-84-2	0.0036	0.0007	20
19	Heptanenitrile[3]	629-08-3	0.0045	0.0005	12
20	2-Octanone[3]	111-13-7	0.0029	0.0007	24
21	n-Decane[3]	124-18-5	0.0074	0.0013	18
22	n-Undecane	1120-21-4	0.044	0.012	27
23	n-Dodecane[3]	112-40-3	0.81	0.19	24
24	n-Tridecane[3]	629-50-5	4.00	1.32	33
Sum of positively identified compounds:			40.00	mg/m^3	

1. CAS = Chemical Abstract Service.

2. RSD = relative standard deviation.

3. Two or more samples were outside the calibration range.

Table X-5
Tank TY-103 Comparison of Organic Compounds in TST and SUMMA^{TM} Samples

Compound	CAS[1] Number	TST Average (ppmv)	SUMMA^{TM} Average (ppmv)
1,1-Dichloroethene (vinylidene chloride)	75-35-4	0.0032	< 0.005
Dichloromethane (methylene chloride)	75-09-2	< 0.0013	< 0.005
Propanone (acetone)	67-64-1	0.042	0.13
Ethanenitrile (acetonitrile)	75-05-8	0.040	0.075
Propanenitrile	107-12-0	0.0088	0.017
Butanenitrile	109-74-0	0.012	< 0.005
Benzene	71-43-2	0.0047	< 0.005
Toluene	108-88-3	0.011	0.013
n-Hexane	110-54-3	0.0081	0.38
n-Heptane	142-82-5	0.0065	0.006
n-Decane	124-18-5	0.0074	0.006

1. CAS = Chemical Abstract Service.

Table X-6
Tank TY-103 Tentatively Identified Organic Compounds in SUMMA™ Samples

Cmpd #	Compound	CAS[1] Number	Average (mg/m^3)	Standard[2] Deviation (mg/m^3)
1	Propane	74-98-6	0.23	0.02
2	Methanol (methyl alcohol)	67-56-1	0.17	0.01
3	n-Butane	106-97-8	0.08	< 0.01
4	2-Propanol[3] (isopropyl alcohol)	67-63-0	0.06	< 0.01
5	3-Buten-2-one	78-94-4	< 0.03	--
6	1-Butanol	71-36-3	0.55	< 0.01
7	Pentanal	110-62-3	0.08	< 0.01
8	Hexanal	66-25-1	0.08	< 0.01
9	Nitric acid, butyl ester	928-45-0	0.05	< 0.01
10	Unknown Alcohol[4]		0.08	--
11	Octanal	124-13-0	0.07	< 0.01
12	n-Undecane	1120-21-4	0.36	0.02
13	n-Dodecane	112-40-3	7.19	0.29
14	Undecane, 2,6-dimethyl-	17301-23-4	< 0.08	--
15	Unknown C12 Alkene/Cycloalkane		< 0.08	--
16	Unknown C14 Alkane		0.09	0.003
17	n-Tridecane	629-50-5	13.86	0.71
18	Unknown C12 Ketone		0.18	0.05
19	Unknown Alkane[4]		0.05	--
20	n-Tetradecane	629-59-4	5.20	0.95
21	Unknown Ketone		0.09	0.05
Sum of tentatively identified compounds:			28.33	

1. CAS = Chemical Abstract Service.

2. When the analyte was detected in only 2 samples, the entry is the relative difference (i.e., their difference divided by 2).

3. Detected in only two samples.

4. Detected in only one sample.

Table X-7
Tank TY-103 Tentatively Identified Organic Compounds in TST Samples

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
1	Methanol and Acetone		0.11	0.04
2	Ethanol	64-17-5	0.018	0.031
3	Trichloromonofluoromethane	75-69-4	0.12	0.003
4	2-Propanol (isopropyl alcohol)	67-63-0	0.011	0.018
5	1-Propanol	71-23-8	0.0099	0.0172
6	Pentanal	110-62-3	0.032	0.028
7	Hexanal	66-25-1	0.050	0.044
8	Tetrachloroethylene	127-18-4	0.056	0.005
9	Cyclotrisiloxane, hexamethyl	541-05-9	0.048	0.082
10	Heptanal	111-71-7	0.061	0.030
11	Cyclotetrasiloxane, octamethyl	556-67-2	0.027	0.046
12	Octanal	124-13-0	0.033	0.030
13	Nonanal	124-19-6	0.034	0.007
14	3-Dodecene, (E)-	7206-14-6	0.13	0.01
15	3-Dodecene, (E)-	7206-14-6	0.046	0.003
16	4-Dodecene	2030-84-4	0.031	0.006
17	Undecane, 2,6-dimethyl-	17301-23-4	0.069	0.006
18	Cyclohexane, hexyl	4292-75-5	0.058	0.007
19	Dodecane, 4-methyl-	6117-97-1	0.030	0.003
20	Undecane, 2,10-dimethyl-	17301-27-8	0.054	0.004
21	Tridecane, 7-methyl-	26730-14-3	0.15	0.01
22	4-Nonene, 5-butyl-	7367-38-6	0.081	0.140
23	1-Pentanol, 4-methyl-2-propyl	54004-41-0	0.012	0.020
24	Dodecane, 2,6,10-trimethyl	3891-98-3	0.0076	0.0132
25	4-Nonene, 5-butyl-	7367-38-6	0.030	0.027
26	4-Nonene, 5-butyl-	7367-38-6	0.032	0.055
27	5-Undecene, (E)-	764-97-6	0.031	0.054

Cmpd #	Compounds	CAS[1] Number	Average (mg/m^3)	Standard Deviation (mg/m^3)
28	6-Tridecene	24949-38-0	0.11	0.02
29	Decane and others		0.036	0.007
30	Cyclohexane, pentyl	4292-92-6	0.082	0.014
31	Tridecane, 2-methyl-	1560-96-9	0.046	0.009
32	Decane, 3,8-dimethyl-	17312-55-9	0.048	0.009
33	6-Dodecanone	6064-27-3	0.41	0.15
34	Cyclododecane, ethyl	28981-49-9	0.0088	0.0153
35	Cyclotetradecane	295-17-0	0.038	0.008
36	3-Dodecanone	1534-27-6	0.26	0.07
37	n-Tetradecane	629-59-4	14.72	2.00
38	Dodecane, 2,6,10-trimethyl	3891-98-3	0.046	0.012
39	6-Tridecanone	22026-12-6	0.88	0.29
40	3-Tridecanone	1534-26-5	0.62	0.19
41	n-Pentadecane	629-62-9	0.58	0.10
42	2-Tridecanone	593-08-8	0.54	0.29
43	1,1'-Biphenyl, 2-chloro-	2051-60-7	0.038	0.006
44	6-Dodecanone	6064-27-3	0.33	0.08
45	3-Tetradecanone	629-23-2	0.15	0.03
46	2-Tetradecanone	2345-27-9	0.11	0.02
47	Heptadecane 9-octyl	629-99-2	0.091	0.158
48	Benzenesulfonamide, N-butyl	3622-84-2	0.064	0.059
49	n-Hexadecane	544-76-3	0.53	0.92
50	Isopropyl Palmitate	142-91-6	0.017	0.029
51	2-Methyloctadecane		0.30	0.52
Sum of tentatively identified compounds:			21.42	

1. CAS = Chemical Abstract Service.

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