CLINTON ENGINEER WORKS - TENNESSEE EASTMAN CORPORATION

Process Improvement Division

Technical Report

TITLE : VACUUM PROBE, STANDARD LEAKS, AND NEEDLE VALVE FOR
USE WITH THE HELIUM LEAK DETECTOR

ABSTRACT : Part I of this report deals with the development and use of a vacuum probe for leak hunting with the Helium Leak Detector. The probe consists of a small sensitive needle valve equipped with a handle. A special feature is the ease in cleaning the probe when it becomes clogged. Use in the plant has shown this probe to be very satisfactory.

Part II describes two types of Standard Leaks, one adjustable, the other fixed, which were designed for measuring the sensitivity of the Helium Leak Detector by the two leak method. Both types have been proved satisfactory in laboratory and plant tests. A sketch shows the set-up used for measuring the sensitivity of the leak detector with a Standard Leak. A special feature of both types is the four 240 mesh stainless steel screens arranged in series in the inlet to keep dirt from clogging the constriction. The adjustable type may be disassembled easily for cleaning.

Part III deals with the development of a needle valve with fine adjustment for controlling the flow of a standard mixture of helium and air into the leak detector for a sensitivity check by the single leak method.

Part IV describes a worm and gear adjustment developed for use with the 3/8" Kerotest angle valve to facilitate throttling of the Helium Leak Detector on a vacuum header equipped with this valve.

AUTHOR: T/4 A.J. Samuel
Bldg. 9766

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VACUUM PROBE, STANDARD LEAKS, AND NEEDLE VALVE FOR USE WITH THE HELIUM LEAK DETECTOR

I. Vacuum Probe for leak hunting with the Helium Leak Detector

A vacuum probe in the form of a needle valve (TEC DWG. NO. D4B-12931, redrawn from PI drawings) has been developed and proven very satisfactory from laboratory tests, as well as actual usage in the plant during the past month and a half.

The vacuum probe is used as follows. The probe having a short handle is connected to the end of a piece of flexible tubing (rubber, or metal, see paragraph regarding flexible tubing) while the other end of the tubing is connected to the leak detector. Hence the tubing up to the probe is under vacuum. The probe valve is then opened slightly, allowing air to pass into the leak detector, to obtain a pressure which is correct for operation of the leak detector. This flow amounts to 4 - 5 micron liters per second for both the General Electric and Westinghouse Leak Detectors. The system to be tested for leaks is placed under a pressure of 5 to 10 pounds of helium, depending on the system, and the probe is then moved over the joints in the system. If the probe passes over a leaky joint helium will pass into the probe and thence into the leak detector where evidence of its presence is shown.

Continued operation of the probe over dirty surfaces may cause it to become clogged. This condition is remedied by opening the valve further and blowing the dirt out with compressed air. One feature of this probe which is necessary is a small dead volume between the nose on the probe and the restricted opening of the valve. This is to insure quick response to changes in helium concentration, so that the leak in the system may be precisely located. The valve is very easily disassembled, cleaned, and put back together.

Two types of tubing have been used with success. The first is rubber tubing 1/4" I.D. and 3/16" wall. Before use it must be processed by boiling about one hour in KOH solution and then outgassed in a vacuum chamber with the application of heat. A 12 foot length of this rubber tubing after treatment has a natural outgassing rate of about 0.33 micron liters per second. The second type tubing is flexible metal hose (bronze 5/32" I.D., 15/32" O.D., with braid) which has a lower natural outgassing rate than does the processed rubber tubing.

II. Standard Leaks for testing the sensitivity of the Helium Detector by the two leak method.

A valve type (adjustable) PI DWG. NO. B-502722 and a rolled tubing type (non-adjustable) PI DWG. NO. A-502599 have been developed and tested with very satisfactory results. One of each type has been in use in the plant for a month with continued satisfactory operation. A large number of the valve type for use in the plant are at present almost completed.

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Both types have a filter system of four 240 mesh stainless steel screens in series on both inlets to keep them clean. Two inlets are provided to allow helium to continually flow past the constriction in the leak. The filters, which are easily replaceable, are in a sense self cleaning as the same inlet will not always be used. Both types are completely enclosed except for the inlets, and have a lucite window under which the calibration is placed. The advantage of the valve type is that it is easily set to the desired value and can be disassembled, cleaned, and reset very easily should it get clogged with dust or dirt. These two types are considered the most practical of the adjustable and non-adjustable types tested.

The test set-up used for following the day by day calibration consisted of two setups on a single large vacuum system as shown by the sketch on page 7. During the whole test, which varied in different cases from six days to as long as a month, air was continually passing through the leak. The method used for measuring the leak was by the rate of rise in the system of known volume (3 liters in this case). In all measurements the base rate of rise of the system is subtracted from the rate of rise due to the system plus the standard leak, and then multiplied by the volume of the system, to obtain the size of the leak.

Observation of ambient temperature was made at the same time day by day calibration checks were made. No effect on the actual calibration was observed on either of the two types of leaks for temperatures ranging from 27 to 37° C. Both values of rate of rise required for calibration did increase with temperature (hence the necessity of measuring the base rate of rise due to the system alone if it is appreciable compared to the total) but when subtracted the result did not show up as a temperature variable quantity. Total variation in calibration values for the two types developed were less than plus or minus 4 percent from an average value, while the probable error in making the measurements was about plus or minus 1-1/2 percent. A calibration check was made on the ion-gauge power supply each time readings were taken. The ion-gauge was kept on during the entire test. The fact that the viscosity of air is very much the same as that of helium allows air to be used during the calibration tests, as well as in actual calibration of standard leaks for the plant.

Until the development of these two types of standard leaks there were none in the plant which were at all reliable, even for the shortest length of time. Most trouble was caused by the constriction in the standard leak getting clogged with dirt, mainly because no means was provided to keep it clean, such as by the use of a filter. They were made by hammering a piece of copper tubing (1/4 inch size) flat on the end, and soldering along the flat on the end, not allowing the solder to go inside. A file was then used to open up a small constriction.

Also tested was a glass capillary type leak, which was easily made, but which clogged on one occasion. This type is probably not desirable in view of the fact that the constriction is a hole rather than a slot, as in the valve and rolled tubing types. The fact that it is easily broken is an undesirable feature.

Another type leak might be made by flattening about 1/2 inch of the end of a piece of 1/4 inch copper tubing in a hydraulic press. This was not tried because it was thought better control of the constriction would be obtained by rolling small tubing (1/16 inch O.D., 0.018 WALL stainless steel type 304) between rollers which are accurately set.

Calculations show that a piece of wire 0.005 inches in diameter placed inside a piece of hypodermic tubing 0.006 inches inside diameter and 6 inches long should give a leak of the correct size. This was not considered practical because this type tubing is not furnished with small tolerances on the inside diameter, thus making it necessary to have special wire sizes. It would have the advantage, however, that the wire could be pulled out and cleaned. Bending of the tubing with the wire in it might have an appreciable effect on the calibration.

One important point to remember about the non-adjustable type standard leak is that in most cases when they become clogged 100 psig air pressure will not clean them, and they have to be discarded.

A sketch showing the test setup used in measuring the sensitivity of a helium leak detector by the use of a standard leak is shown below.

The size of standard leak used for sensitivity checks on both the Westinghouse and General Electric Helium Leak Detectors is from 0.05 to 0.10 micron liters per second. A ratio M (see below) of about 5000:1 should give a deflection of about 2/3 of the full scale range on both detectors. The sensitivity is given by the following equation. (This equation applies to both the single and double leak methods).

$$S = \frac{1}{M \frac{(X - X_0)}{\Delta X}}$$

where: S = sensitivity in terms of parts of helium detectable in so many parts of air

M = ratio of parts of air per part of helium admitted to detector

X = scale deflection obtained when the mixture is admitted to the detector

X₀ = scale deflection with no helium

Δ X = minimum change in scale deflection required for positive detection.

Assuming the size standard leak to be 0.075 micron liters per second the size air leak required for a ratio M of 5000 parts air to 1 part helium would be 375 micron liters per second, or 0.507 cc per second of air at 740 mm of Hg. The ratio chosen is a convenient one which will bring the pressure in the vacuum header somewhere between 50 and 100 microns, so that the throttling valve may be set to obtain the correct pressure in the leak detector vacuum system required for operation. An independent mechanical pump of at least 43 CFM is desired for these conditions.

III. Needle Valve for controlling the flow of a standard mixture of helium and air into the helium leak detector for a sensitivity check by the single leak method.

A needle valve for admitting a standard mixture of helium and air into the leak detector for a sensitivity check has been developed and proven satisfactory in laboratory tests (PI DWG. NO. B-504615). It has four 240 mesh stainless steel screens in series to act as filters in keeping the valve clean. The packing is made of rubber tubing which has been tested and found not to leak at pressures as high as 75 psig air pressure. The design of the needle and seat offers very fine control.

The quantity of flow required for measuring the sensitivity of the General Electric and Westinghouse Helium Leak Detectors is about 4 to 5 micron liters per second. Orders have been placed for a number of these for plant use.

- IV. Worm and gear attachment for use with the 3/8 inch Kerotest Angle Valve to facilitate throttling of the Helium Leak Detector on a vacuum header to which systems to be checked for leaks are also attached.

This method of control was originally used by R. Lovinger on his cold cathode helium leak detector.

A compact worm and gear attachment (TEC DWG. NO. C4e-13133) has been built for attachment to a 3/8" Kerotest Angle Valve. The first one built was used in the plant with very satisfactory results.

The worm and gear combination has a ratio of 20: 1. It does not require disassembling of the valve from the system for installation, but merely slips over the valve bonnet and is held fast by a bolt and split collar arrangement.

Orders have been placed for one for each Helium Leak Detector in the plant.

A. J. Samuel

A.J. Samuel

map/

SCHEMATIC DRAWING OF SETUP FOR CALIBRATION OF STANDARD LEAKS

VACUUM PROBE TEC DWG. NO. D4b-12931

689-8

B

1/8

1/16 DRILL THRU
5/16 DRILL - 3/8 DEEP

THIS DIMENSION IS ONLY APPROX., EXACT THICKNESS IS DETERMINED BY TRIAL FOR ANY GIVEN SIZE LEAK.

EASY FLOW * SOLDER
VACUUM TIGHT

1/8 .0315 AFTER * ROLLING

FLATTEN THIS LENGTH
IN ROLLER

BLOW INSIDE OF TUBING OUT
WITH CLEAN DRY GAS FROM
A CYLINDER BEFORE ROLLING.

3/4
1/8

THE HOLDER (INCLUDING FILTER) FOR THIS STANDARD
LEAK IS SHOWN ON ASSEM. DWG. A-502736

* SOLDER BEFORE ROLLING, BEND OPEN END FAR
OFF TO SIDE TO KEEP INSIDE OF TUBING CLEAN WHILE SOLDERING.

BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED
TOLERANCE UNLESS OTHERWISE SPECIFIED - FRACTIONS $\pm \frac{1}{16}$ DECIMALS $\pm .005$

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APPROVED FOR OPERATION		DATE	APPROVED FOR DESIGN		DATE	DRAWN		CLINTON ENGINEER WORKS TENNESSEE EASTMAN CORPORATION OAK RIDGE, TENN.	
WORKS MANAGER			CHIEF ENGR.			7/4/55		STANDARD LEAK ASSEMBLY	
ASS'T WORKS MANAGER			MECH. ENGR.			TRACED			
MGR. OF ENGR.			CHEM. ENGR.			CHECKED			
PRODUCTION MGR.			CIVIL ENGR.			COMPT'D			
DIVISION SUPT.			ELEC. ENGR.			SCALE		SHEET NO. SHEETS OF	
REVISION		BY	DATE	PLANT PROT. SUPT.		DOUBLE		DRAWING NUMBER A 502599	

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ITEM	ENG. NO.	QTY	PART
A	A-502737	1	BODY
B	A-502738	1	SLEEVE PLUG
C	INSTR. APP. 3460 RE. #19, DATE. 46-11472	1	NUT
D	A-502739	2	HOSE HOLDER
E	A-502740	2	HOLLOW SET SCREW
F	A-502741	8	FILTER
G	A-502742	1	WINDOW
H	A-502743	1	CAP

SOLDER ALL-AROUND WITH EASY-FLOW!

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TOLERANCE UNLESS OTHERWISE SPECIFIED — FRACTIONS $\pm$ DECIMALS $\pm$

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		WORKS MANAGER			CHIEF ENGR.			DRAWN		H. J. Smith 4/26/48	
		ASS'T WORKS MANAGER			MECH. ENGR.			TRACED			
		MGR. OF ENGR.			CHEM. ENGR.			CHECKED		H. J. Smith 6-26	
		PRODUCTION MGR.			CIVIL ENGR.			COMPT'D		J. O. Smith 4-27	
		DIVISION SUPT.			ELEC. ENGR.					SHEET NO. SHEETS - PROJECT	
REVISION		BY	DATE	C. E. Norman	6/27	PLANT PROT. SUPT.			SCALE	FULL	OF
											147 A502736

HOLDER FOR STD LEAK ASSEMBLY

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TEST PROCEDURE

TEST VALVE, JUST WITH ITEMS A, B, C, I, AND J ASSEMBLED, FOR LEAKS THRU THE NEEDLE BY APPLYING 50* AIR PRESSURE TO THE VALVE (BY MAKING CONNECTION TO NUT (I)) AND IMMERSING VALVE IN WATER.

IF VALVE LEAKS THROUGH THE NEEDLE, LAPP WITH "ALUNDUM 600" DO NOT USE CARBUNDRUM. DO NOT TRY TO JAM SEAT, AS THIS WILL SPOIL SEAT. RETEST AFTER LAPPING.

BEFORE ASSEMBLING VALVE

1. BE SURE INSIDE OF BODY AND NEEDLE ARE FREE FROM ANY FOREIGN PARTICLES AND LIQUIDS BEFORE ASSEMBLING. WASH BOTH THOROUGHLY WITH CARBON TETRACHLORIDE, OR SUITABLE SOLVENT AND THEN BLOW DRY WITH DRY AIR BLAST.

ITEM	DWG. NO.	Q'TY	PART
A	B-502723	1	BODY
B	A-502724	1	NEEDLE
C	A-502725	1	ELAND NUT
D	A-502726	1	NEEDLE STOP NUT
E	A-502727	1	COVER
F	A-502728	1	WINDOW
G	A-502729	1	CAP
H	A-502730	2	HOSE FITTING
I	A-502731	1	NUT
J	A-502732	2	SCREW
K	A-502733	8	FILTER
L	A-502734	1	WASHER
M	A-502735	1	PACKING

NOTE 1. SELECT A NEEDLE AND REAM SEAT UNTIL THIS DIMENSION IS OBTAINED WITH VALVE CLOSED. NEEDLES AND BODIES ARE NOT INTERCHANGEABLE AFTER REAMING IS COMPLETED. (THIS DIMENSION APPLIES ONLY AFTER REAMING)

BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED

TOLERANCE UNLESS OTHERWISE SPECIFIED — FRACTIONS $\pm \frac{1}{64}$ DECIMALS $\pm .005$

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WORKS MANAGER			CHIEF ENGR.			DRAWN <i>Ed. D. Smith</i> 4/5/45	
ASS'T WORKS MANAGER			MECH. ENGR.			TRACED	
MGR. OF ENGR.			CHEM. ENGR.			CHECKED <i>H. D. Smith</i> 6-26	
PRODUCTION MGR.			CIVIL ENGR.			COMPT D	
DIVISION SUPT.			ELEC. ENGR.			SCALE <i>DOUBLE</i>	
REVISION		BY	DATE	PLANT PROT. SUPT.		PROJECT <i>147</i> DRAWING NUMBER <i>B502722</i> REV. <i>1</i>	
[A] CH. TO GO WITH REV. [A]		<i>CE</i>	<i>7/19/45</i>			SHEET NO. SHEETS <i>147</i> OF <i>147</i>	
[B] ADD. "ALUNDUM 600"		<i>CE</i>	<i>7/19/45</i>			STD. LEAK FOR L.D. ASSEMBLY	
[C] TOL. ON HOLE TO NUT AFTER REAMING		<i>CE</i>	<i>7/19/45</i>			689-11	

ISSUED
4th J B 1846
CEW-TEP

BEFORE ASSEMBLING VALVE

BE SURE INSIDE OF BODY AND NEEDLE ARE FREE FROM ANY FOREIGN PARTICLES AND LIQUIDS. WASH BOTH THOROUGHLY WITH CARBON TETRACHLORIDE, OR SUITABLE SOLVENT, AND THEN BLOW DRY WITH DRY AIR BLAST.

TEST PROCEDURE

TEST VALVE JUST WITH ITEMS A, B, C, H, AND K ASSEMBLED FOR LEAKS THROUGH THE NEEDLE AND GLYPTOL PIPE JOINT, (SOLDERED JOINT PREVIOUSLY TESTED, SEE DWG NO. A-504619) BY APPLYING 50 PSI AIR PRESSURE TO ADAPTER (H), AND IMMERSING VALVE IN WATER.

IF VALVE LEAKS THRU THE NEEDLE, LAPP WITH "ALUNDUM 600" DO NOT USE CARBURUNDUM. DO NOT TRY TO JAM SHUT, AS THIS WILL SPOIL SEAT. RETEST AFTER LAPPING.

IF VALVE LEAKS THRU GLYPTOL JOINT, DISASSEMBLE, RE - GLYPTOL, AND RETEST.

USE RED GLYPTOL PLATE ON END HALF OF MALE THREADS BEFORE ASSEMBLING.

ITEM	DWG. NO.	Q'TY	PART
A	A-504616	1	BODY
B	A-504617	1	NEEDLE
C	A-502725	1	GLAND NUT
D	A-502726	1	NEEDLE STOP NUT
E	A-502734	1	WASHER
F	A-502735	1	PACKING
G	A-504618	1	HOSE FITTING
H	A-504619	1	ADAPTER
I	A-502733	4	FILTER
J	4-40 x 3/8 S.S. FIL. HD. M.S.	2	SCREEN
K	GENERAL RADIO NO. 637A	1	KNOB

NOTE 1. SELECT A NEEDLE AND REAM SEAT UNTIL THIS DIMENSION IS OBTAINED WITH VALVE CLOSED. NEEDLES AND BODIES ARE NOT INTERCHANGEABLE AFTER REAMING IS COMPLETED. (THIS DIMENSION APPLIES ONLY AFTER REAMING.)

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		WORKS MANAGER		CHIEF ENGR.		DRAWN	T. A. Smith / 7/16/45	NEEDLE VALVE FOR L.D. ASSEMBLY	
		ASS'T WORKS MANAGER		MECH. ENGR.		TRACED			
		MGR. OF ENGR.		CHEM. ENGR.		CHECKED			
		PRODUCTION MGR.		CIVIL ENGR.		COMPT'D			
		DIVISION SUPT.		ELEC. ENGR.				SHEET NO. SHEETS	PROJECT
				PLANT PROT. SUPT.		SCALE	DOUBLE	OF	DRAWING NUMBER
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