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Laboratory Testing - Adsorption Processes

I. INTRODUCTION

Design of a new solvent recovery system or evaluation of the performance of an existing solvent recovery equipment starts with an analysis of the performance of the adsorbent. If this analysis is to yield usable results, it must be done under carefully controlled conditions. It is well understood that failure to accurately reproduce the solvent mix and operating conditions will generate inaccurate data. NUCON International, Inc., has the people, the equipment and the proper techniques for performing these critical analytical tests.

The objective of such a test series is to determine the mass transfer zone (MTZ) length and rate of travel and working charge vs. steam/solvent ratio for both new and used adsorbents. The type of adsorbent used and the process parameters (solvent concentration, humidity, air velocity, etc.) can be matched to the required design conditions.

II. TYPICAL EQUIPMENT AND INSTRUMENTATION

- Adsorption apparatus consisting of a 2" diameter glass column which can be filled with candidate adsorbent to a bed depth of 20 inches.
- Calibrated Solvent Injection Systems
- Humidification system based on the "two-pressure" principal.
- Total Hydrocarbon and Other Analyzers
- Gas Chromatographs
- Rotameters, Pressure Gauges, Thermocouples, etc.

III. METHODOLOGY

A. Adsorption Cycle

The solvent vapor, generated by calibrated injection of solvent(s) into a heated manifold, is mixed with humidified air and passed through the adsorbent bed. Both inlet and outlet solvent vapor concentrations, the pressure drop across the bed and inlet and outlet temperatures are monitored.

B. Desorption Cycle

Solvents are desorbed from the adsorbent bed using steam. The adsorbent bed is insulated and heated externally during the desorption cycle to make up for heat losses.

The saturated steam can be superheated if needed prior to introducing it into the adsorbent bed. Typically, the flow of regenerant is counter current to the adsorption flow. The steam solvent mixture exiting the adsorbent bed is condensed. Twenty-five ml fractions are collected until a cumulative steam-solvent ratio of 5:1 is obtained. A sample curve showing steam to solvent ratio vs. working charge is shown in attached Figure 2.

IV. PRESENTATION OF RESULTS

Process parameters and the summary of the results are recorded on NUCON Form FT-53.

Mass Transfer Zone (MTZ) length and rate of travel are calculated as follows: (See FT-53, Table 2)

$$U = L/t_{50}$$
$$M = U \ t$$

Where:

U	=	rate of travel, in./min.
L	=	length of bed, inches
t_{50}	=	time to 50% breakthrough, minutes
M	=	mass transfer zone length, inches
t	=	(time to saturation) - (time to breakthrough), minutes

The breakthrough curves for the virgin adsorbent and for the adsorbent after the working charge test completion are shown in Figure 3.

Figure 3

Breakthrough Curve for Adsorption of

2000 ppmV Toluene on Carbon GC60–3

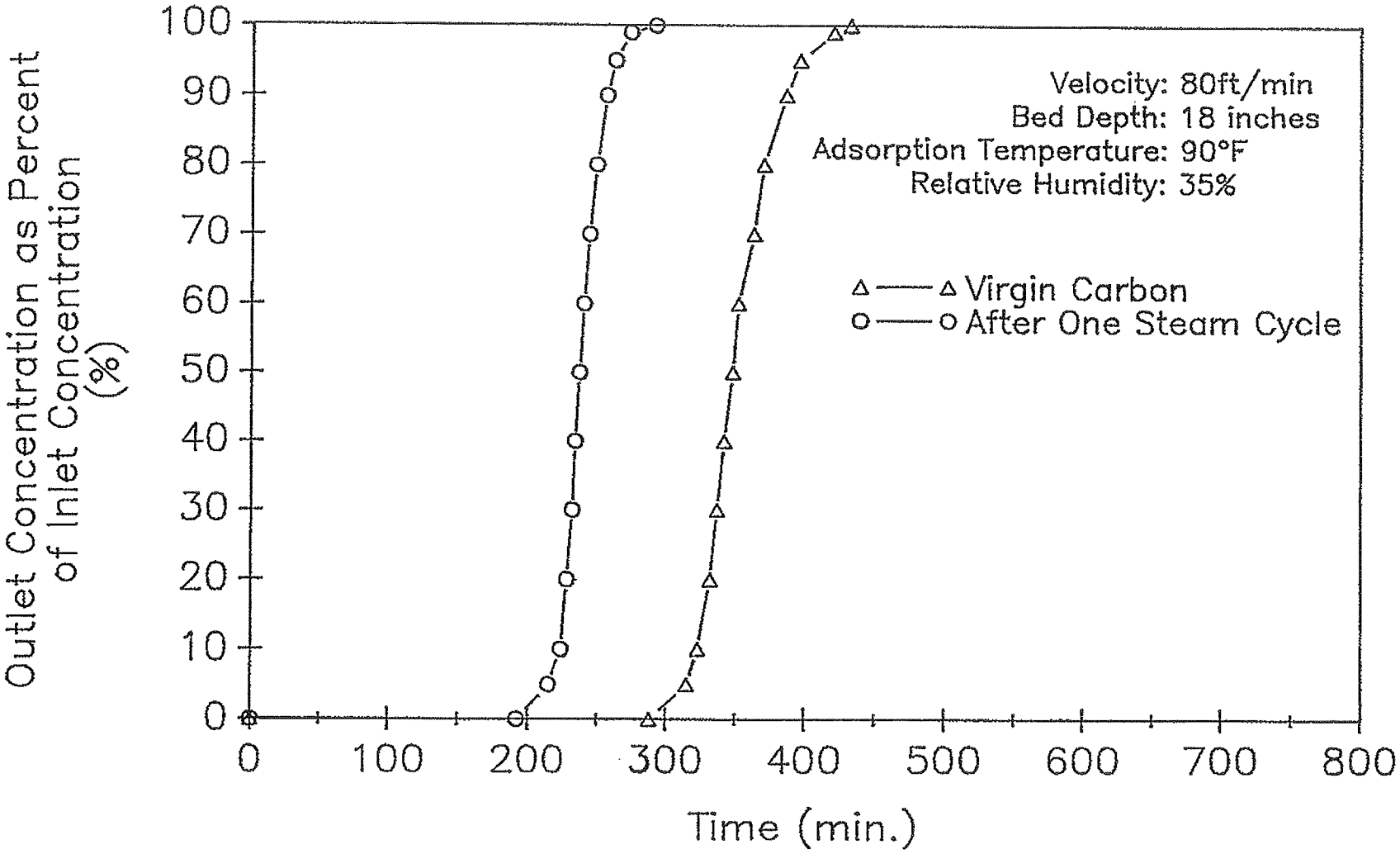
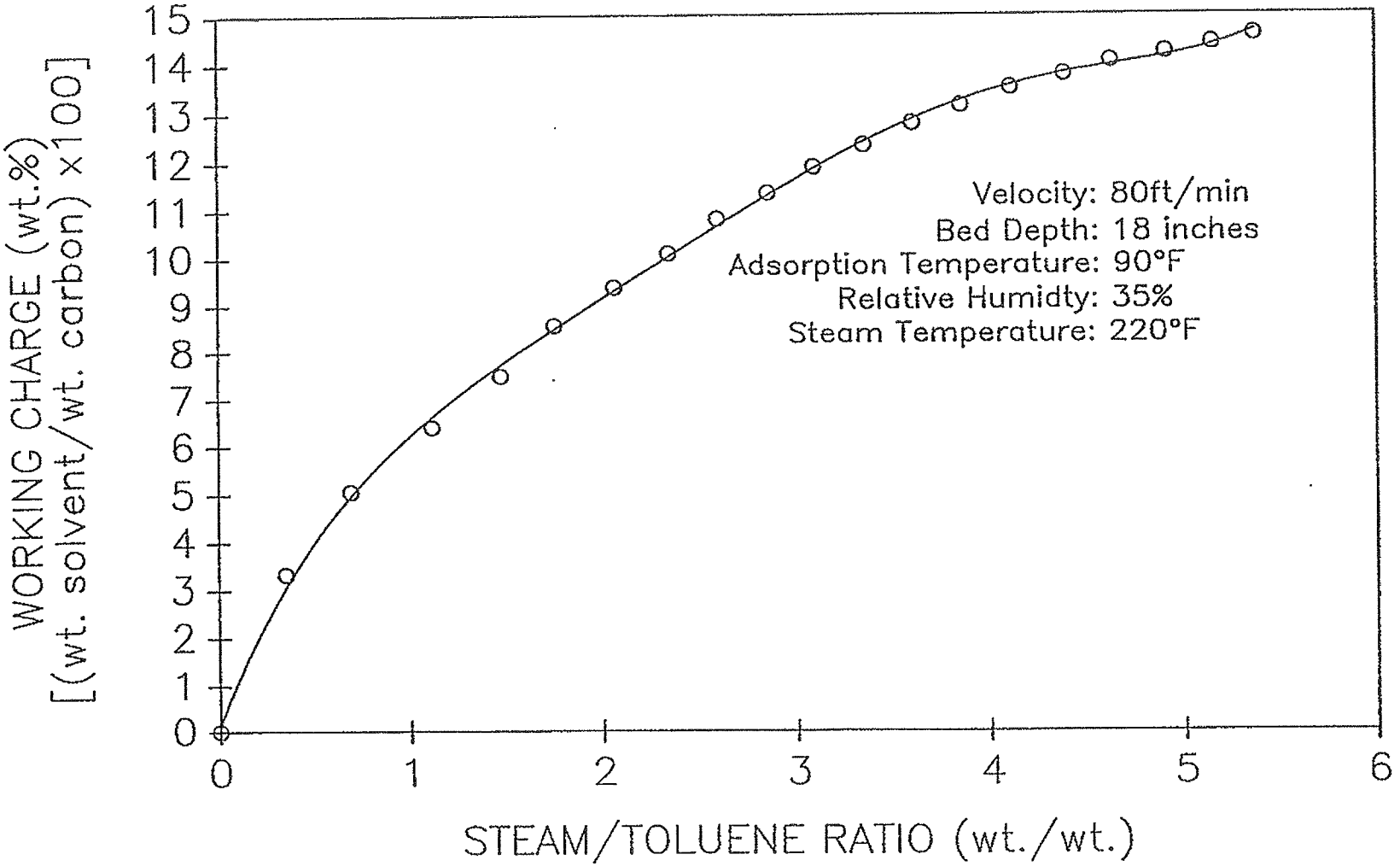
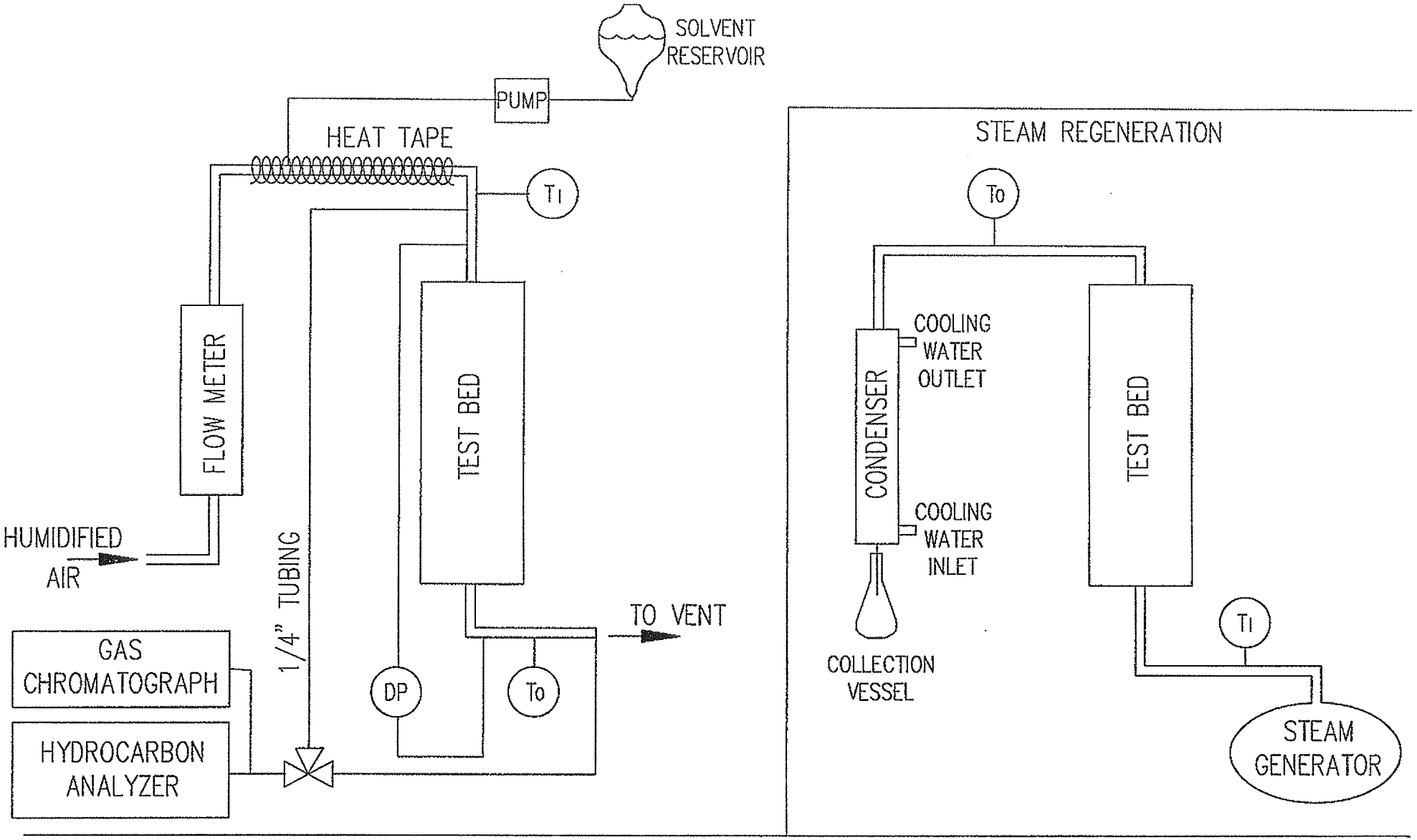


Figure 2

STEAM TO SOLVENT RATIO vs WORKING CHARGE FOR ADSORPTION OF 2000 ppmV TOLUENE ON CARBON GC60-3





TI : INLET TEMPERATURE
To : OUTLET TEMPERATURE
DP: DIFFERENTIAL PRESSURE

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