42-143-2

AMERICAN OIL COMPANY

TEXAS CITY, TEXAS

RESEARCH AND DEVELOPMENT DEPARTMENT

RESEARCH DIVISION

PETROLEUM SECTION

MEMORANDUM

ATM56-26
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3-28-56

Proposal for Measuring Seal Gas Leakage at the Ultraformer by a Radiotracer Technique

SUMMARY

This memorandum presents a proposal for the use of radioactive krypton to measure the amount of valve seal gas which leaks into the process system at the Ultraformer. Krypton-85 will be added to the seal gas until a steady state concentration is obtained in the make gas. (The latter is largely hydrogen.) Using the known total seal gas flow and make gas volume, the percentage of seal gas leakage into the process system will thus be obtained.

Krypton-85 was chosen because of its inertness and its availability at low cost. It is estimated that 500 millicuries per hour will be required and that steady state conditions will be reached in one hour. One curie of krypton-85 can be purchased for $65. The radioactivity level resulting from leakage into the air around the unit has been calculated and found to present negligible hazard. A license from the AEC, Isotopes Extension, Division of Civilian Application will be required for the purchase and use of the radioactive gas.

INTRODUCTION

In the Ultraformer, inert gas is used to seal valves which admit or block either process gas or regeneration gas to the reactors. If the valve seats are leaking, some of the seal gas leaks into either the process system, the regeneration system, or both. Some also leaks past valve stem packing to the atmosphere. The seal gas contains small amounts of materials which may reduce the activity of the catalyst and lower the yields. Therefore it is desired to know how much of the seal gas is leaking into the process system. There are 36 of these valves, 22 of which are 14-inch, 12 are 8-inch, and 2 are 2-inch.

It is proposed to add radiokrypton to the seal gas at a constant rate until a steady state condition has been reached. The measurement of radioactive krypton in the process make gas will then be a measure of the

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leakage of seal gas into the process system. The volumes of total seal gas leakage and of total process make gas are known. The proposed measurement will tell what proportion of the total seal gas leakage is going into the process stream. The remainder must be leaking into the regeneration system and/or to the atmosphere. If the leakage of seal gas into the process stream is found to be low, installation of expensive purifying equipment will be shown to be unnecessary. A simplified schematic flow diagram of the process is attached.

DISCUSSION

It is estimated that at least one hour will be required to reach steady state conditions. To measure 10% leakage of the seal gas into the process gas is estimated to require the injection of 500 mc/hr. The immediate dilution in the seal gas to 11,000 SCF/hr will result in a concentration of 1.6×10^{-6} mc/ml. If 10% (1,100 SCF/hr) enters the process stream, the equilibrium concentration in the make gas will be 1.6×10^{-9} mc/ml. Samples of the make gas will be taken into 250-ml ionization chambers and the ionization current measured with an Applied Physics Corporation vibrating reed electrometer. Based on C^{14} measurements, the drift rate for a chamber filled with this make gas should be in the range of 0.09 mv/sec compared to a background drift rate of 0.03 mv/sec.

The krypton-85 as received from ORNL will be diluted in nitrogen to a volume sufficient for metered addition to the seal gas system. A glass to metal seal will be attached to the glass ampoule and the metal end fitted to an evacuated pressure cylinder. The krypton will then be expanded into the pressure cylinder and the cylinder filled to atmospheric pressure with nitrogen. The cylinder will then be connected to the catalytic reforming unit seal gas system and the nitrogen containing krypton-85 pressured to 475 lb/in^2 and displaced into the unit line by liquid injected into the pressure cylinder by a constant volume pump.

A portion of the seal gas is expected to leak past valve stem packing and flanges directly to the atmosphere. The valves under consideration are scattered in an area about 30 feet square. Half are 10 feet above the ground and the rest are 20 feet above the ground. With an average wind of 8 mi/hr, the average concentration in the air leaving the reactor area, if all the radiokrypton leaked directly to the atmosphere, would be 7×10^{-10} mc/ml. Personnel would be kept out of an area 50 feet square around the valves during the test.

If all the gas leaked into the process system, it would be diluted to 1.6×10^{-8} mc/ml. This would subsequently be discharged into the unit fuel gas system. Two-thirds of this fuel gas is mixed with 10 volumes of air when it is burned in six furnaces at the unit and the flue gases exhausted from stacks ranging from 60 feet to 180 feet in height. The other third of the fuel gas goes to the general refinery fuel gas system where it undergoes extensive dilution before being burned and exhausted to the atmosphere through furnace stacks.

Radioactive gas leaking into the regeneration system would be exhausted to the atmosphere from a 60-foot stack. The minimum flow in this system is 40,000 SCF/hr so that the maximum concentration in this exhaust would be 4.4×10^{-7} mc/ml.

The maximum permissible concentration of krypton-85 in air for continuous exposure, calculated by equation G3, page 30, NBS Handbook 52, is 3.3×10^{-9} mc/ml. This concentration would give an exposure of 300 mrep/week. Maximum possible dosages during one hour from the concentrations calculated above, which would result if all the krypton leaked in one of the three possible directions, are as follows:

	Max. possible conc. (mc/ml)	Max. dosage (mrep)
Directly from valves to air	7×10^{-10}	0.4
Into process stream	1.6×10^{-9}	0.8
Into regeneration system	4.4×10^{-7}	240

The latter exposure is highly improbable because it assumes all the radioactivity goes into the regeneration system and no dilution with air as the gas leaves the 60-foot stack. An individual would have to be directly in the stack exhaust at the stack opening during the entire test to receive the dosage indicated for the third item in the above table.

The minimum distance down wind at which personnel will be allowed during the test will be 100 feet. The maximum exposure time at this distance will be less than 10 minutes. Since krypton should have no residual effect, radiation exposures should be negligible. Air samples will be taken to monitor any possible exposure. Gamma radiation from the gas ampoule and pressure cylinder will be monitored before handling and necessary shielding constructed. All areas of possible exposure will be marked with radiation warning signs and personnel access restricted.

CONCLUSIONS

The use of radioactive krypton to determine the amount of seal gas leakage into the Ultraformer process system appears to be an ideal radiotracer application. The procedure will be relatively simple and inexpensive. With proper precautions as outlined herein, radiation exposure hazard will be negligible. It is recommended that the project be undertaken, subject to the approval of Isotopes Extension, Division of Civilian Application, Atomic Energy Commission.

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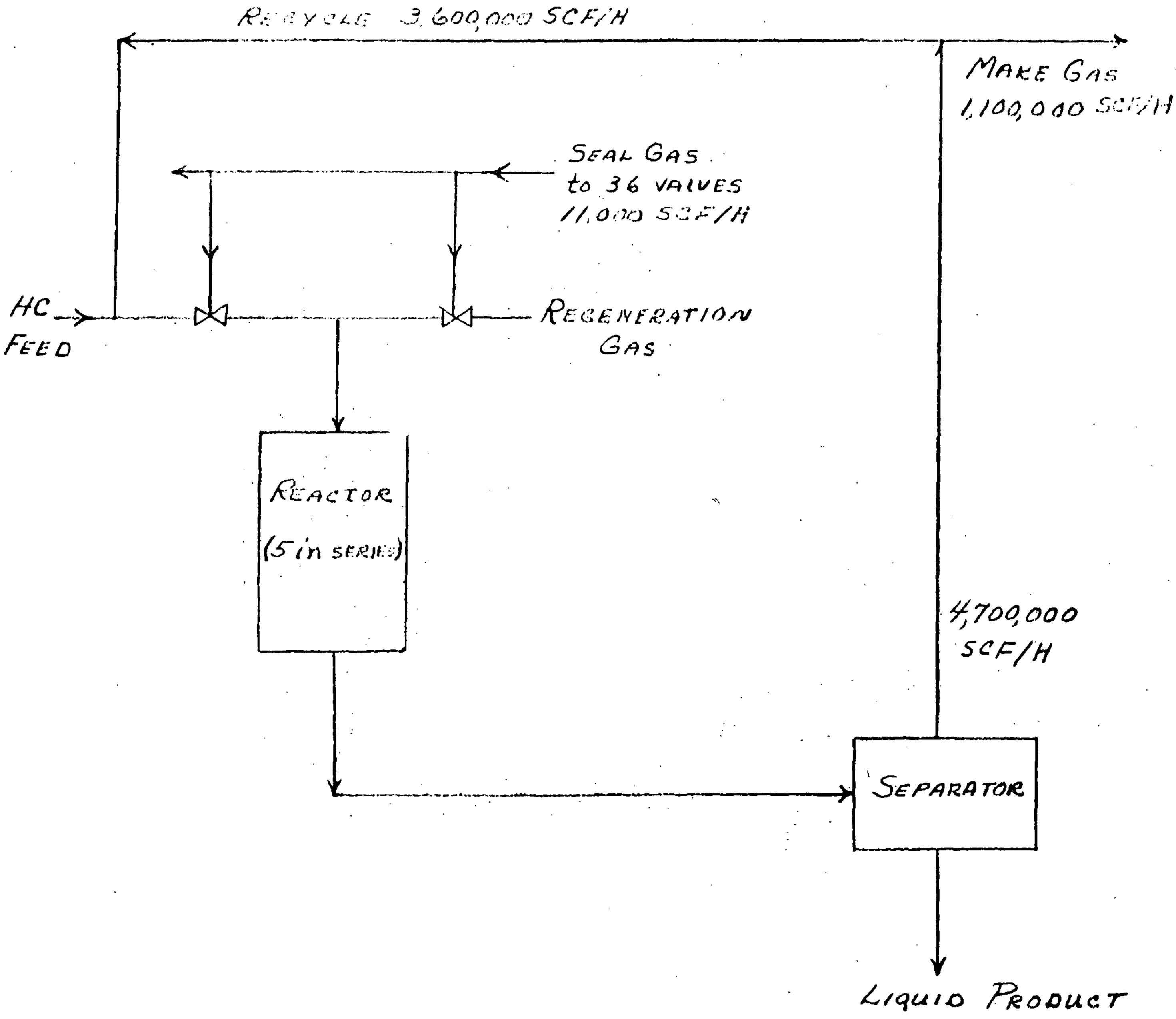

SCHEMATIC OF ULTRAFORMING PROCESS

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3-28-56