UNCLASSIFIED

CF-52-10-38

Subject Category: ENGINEERING

UNITED STATES ATOMIC ENERGY COMMISSION

PRESSURE DROP AND GAS RESIDENCE
TIME FOR A FOUR FOOT CORE

By
Leon Cooper

October 4, 1952

Oak Ridge National Laboratory
Oak Ridge, Tennessee

Technical Information Service, Oak Ridge, Tennessee

UNCLASSIFIED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

2

Date Declassified: December 8, 1955.

This report was prepared as a scientific account of Government-sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights. The Commission assumes no liability with respect to the use of, or from damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

This report has been reproduced directly from the best available copy.

Issuance of this document does not constitute authority for declassification of classified material of the same or similar content and title by the same authors.

Printed in USA, Price 10 cents. Available from the Office of Technical Services, Department of Commerce, Washington 25, D. C.

CF-52-10-38

- Pressure Drop and Gas Residence
Time for a Four Foot Core

By

Leon Cooper

October 4, 1952

Work performed under Contract No. W-7405-Eng-26

OAK RIDGE NATIONAL LABORATORY

Operated By

CARBIDE AND CARBON CHEMICALS COMPANY

POST OFFICE BOX P

OAK RIDGE, TENNESSEE

Pressure Drop and Gas Residence Time for a Four Foot Core

Introduction

Calculations of the pressure drop and gas residence time are presented here for a 4 ft. spherical core in a rotational flow reactor. The reactor considered has two tangential inlets at the equatorial plane and two axial outlets at the poles.

The pressure drops have been calculated for the case of a total volumetric flow rate of 5000 gpm and for two different inlet velocities: 15 ft/sec and 25 ft/sec. The Uranium content is 5g/l and the temperature assumed is 250°C.

The pressure drops for each of the cases has been calculated according to three different equations for the sake of comparison. The equations are as follows:

$$\begin{aligned}
 (1) \quad (\Delta P)_1 &= \frac{\rho V^2}{2\pi^2 g_c R_1^4} \left\{ \frac{1.25}{N_1} \left[\left(\frac{R_s}{R_2} \right)^{1.6} - 1 \right] + \frac{1}{N_2^2} \left(\frac{R_1}{R_2} \right)^4 \right\} * \\
 (2) \quad (\Delta P)_2 &= \left(\frac{15.44 A_1}{\pi R_s^2} \right) \left(\frac{v_1^2}{2g} \right) \left[\left(\frac{R_s}{R_2} \right)^2 - 1 \right] ** \\
 (3) \quad (\Delta P)_3 &= \frac{\rho V^2}{\pi^2 g_c R_1^4} \left\{ \frac{5.7}{N_1^{1.14}} \left(\frac{R_1}{R_s} \right)^{1.72} \left[\left(\frac{R_s}{R_2} \right)^2 - 1 \right] + \frac{0.5}{N_2^2} \left(\frac{R_1}{R_2} \right)^4 \right\} ***
 \end{aligned}$$

* "Nature of Liquid Flow Within a Spherical Container", Second Quarterly Report, University of Tennessee, Department of Chemical Engineering, December 15, 1951.

** Equation obtained from experimental data on 12 inch sphere by I. Spiewak and J. I. Lang

*** Personal Communication from F. N. Peebles. Information will be available in forthcoming report.

- A_1 = area of inlet (L^2)
 N_1 = number of inlets
 N_2 = number of outlets
 R_1 = radius of inlet (L)
 R_2 = radius of outlet (L)
 R_s = radius of sphere (L)
 v_1 = inlet linear velocity (L/T)
 V = volumetric velocity (L^3/T)
 ρ = density of fluid (M/L³)

The equations for the calculation of the gas residence time can be found in a previous report of the author*, as well as a discussion of their origin and derivation.

Results

The results of the calculation are summarized in the following table:

v_1 , ft/sec	$(\Delta P)_1$, psi	$(\Delta P)_2$, psi	$(\Delta P)_3$, psi	$\bar{t}_T$, sec	t_{Lav}
15	53.5	40.0	44.7	.657	3.01
25	230.2	113.9	143.3	.479	3.01

$\bar{t}_T$ = average gas residence time

t_{Lav} = average liquid time in reactor

It can be seen that the average gas residence time is considerably less than the average liquid time in the core which has definite advantages. However, a pressure drop of 40-50 psi is perhaps a high price to pay for the decrease in the complexity of the gas separation problem.

* ORNL Central Files No. 52-1-180, L. Cooper, "The Effects of Scale-Up on the Hydrodynamics of Reactors."