A STUDY OF THE MAXIMUM POWER DESIGN TECHNIQUE FOR DESIGNING HYDRAULIC ACTUATING SYSTEMS

by

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B. Sc., Benaras Hindu University, India, 1966

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Mechanical Engineering

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

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NOMENCLATURE

C_d = coefficient of discharge

P_s = supply pressure, psig

P_d = discharge pressure, psig

P_l = pressure (left side), psig

P_r = pressure (right side), psig

F_L = load force, lb_f

M_p = mass of piston, lb_m

M_L = mass of load, lb_m

B_p = damping coefficient of piston, $\frac{lb_f\text{-sec}}{in}$

B_L = damping coefficient of load, $\frac{lb_f\text{-sec}}{in}$

F_c = coulomb type friction, lb_f

K = spring constant, lb_f/in

F_u = external force, lb_f

A = area of piston, in^2

X = valve opening, in

d = diameter of spool, in

Q_l = flow rate (left side), in^3/sec

Q_r = flow rate (right side), in^3/sec

ρ = density of working fluid, $\frac{lb_f\text{-sec}}{in^4}$

β = bulk modulus of working fluid, lb_f/in^2

NOMENCLATURE (Contd.)

X_{max} = maximum valve opening, in

C = piston travel, in

L = length of cylinder, in

b = piston width, in

$\dot{C}$ = velocity of piston, in/sec

$\ddot{C}$ = rate of change of velocity of piston, in/sec^2

HP = horse power

C_o = initial position of piston from reference surface, in

C_{max} = amplitude of load motion, in

ω_d = design frequency of load motion, rad/sec

V_v = volume of valve, in^3

V_l = volume of transmission lines, in^3

$\overline{P}_l$ = dimensionless pressure (left side)

$\overline{P}_r$ = dimensionless pressure (right side)

$\overline{F}$ = dimensionless force on piston

$\overline{\dot{C}}$ = dimensionless piston velocity

$\overline{HP}$ = dimensionless horse power

$\overline{X}$ = dimensionless valve opening

$\overline{Q}_l$ = dimensionless flow rate (left side)

$\overline{Q}_r$ = dimensionless flow rate (right side)

h = time interval in computer solution

CHAPTER I

INTRODUCTION

Before electric power was invented, hydraulic power (water as the working fluid) was widely used in industries which used steam driven engines and mills. The ease of transmitting electric power from generating station to farthest point left the hydraulic power far behind in the race. Only for last few decades the hydraulic power (oil as the working fluid) is again put to numerous uses. Developments and research in the field of hydraulic power started again at rapid rate when demand power and types of performances which are impossible to obtain with the use of electric power grew more and more. The present demand for large power and high speed of response drew the attention of scientists and engineers towards the development of hydraulic power. The present sophisticated aircraft and numerous defense applications require large power to weight ratio and high frequency response. In case of earth moving equipment and numerous other applications it may be necessary to hold the load at a particular position for some length of time. Among all the presently available techniques hydraulic power is the best suited for these applications. The hydraulic power system has some disadvantages but the advantages in most applications outweigh the disadvantages.