MILITARY UNIVERSITY NUEVA GRANADA

HYDRAULIC SYSTEMS

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1. RESUMEN:

En esta práctica de laboratorio, se realiza el control de sentido de giro de un motor hidráulico utilizando una válvula 4/3 y una reguladora de caudal, que controla la velocidad del motor. A este circuito se le añade un manómetro para conocer la presión con la cual el aceite entra al motor. Medir velocidad del motor al variarla con la válvula de estrangulamiento.

2. PALABRAS CLAVE

-Aceite

-Hidráulico

-Motor

-Fluido líquido

3. ABSTRACT:

In this laboratory practice, the direction of rotation of a hydraulic motor is performed using a 4/3 valve and a flow regulator, which controls the speed of the motor. To this circuit is added a pressure gauge to know the pressure with which the oil enters the engine and to measure the speed of motor using an encoder.

4. KEYWORDS:

-Oil

-Hydraulic

-Motor

-Liquid fluid

5. INTRODUCTION:

Hydraulics is a technology that uses a liquid, in order to transmit energy to perform the various movements and achieve the operation of the mechanisms. It consists of increasing the pressure of the implemented fluid by means of the different elements used to perform the sequence. In this case it will be used to develop different sequences and thus achieve an approach to this technique, analyzing the behaviors of the system.

6. OBJECTIVES

GENERAL OBJECTIVE:

- Perform hydraulic sequences for the movement of actuators.

SPECIFIC OBJECTIVES:

- Recognize the elements to be implemented.
- Develop the simulation and assembly of a hydraulic circuit capable of meeting the specifications.
- Understand and solve the problems raised.
- Develop the different simulations and analyze the behavior of the circuits.

7. THEORETICAL FRAMEWORK:

Hydraulics:

"The process consists of increasing the oil pressure by means of elements of the hydraulic circuit (the compressor) to use it as a useful job, usually in an output element called a cylinder. The increase in this pressure can be seen and studied by Pascal's principle.

The cylinders only have forward and reverse travel in rectilinear movement, that is why if we want another movement we must attach to the cylinder a mechanism that makes the change of movement.

In a hydraulic system the oil replaces the compressed air used in pneumatics. Many excavators, garbage trucks, cars, etc. use hydraulic systems to move mechanisms that are attached to an oil-driven hydraulic cylinder.

As called hydraulics it can be thought that it only uses water, which is not the case, it is more almost never water is used only oil is used. In theory if oil is used it should be called hydraulic oil, but it is not so. In practice when we talk about systems by oil, water or any liquid fluid we use the word hydraulics." [3]

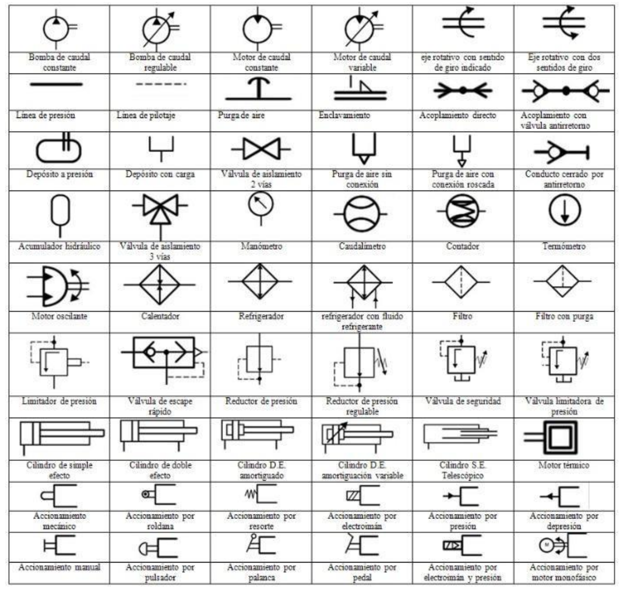

Figure 1. Pneumatic symbology.

Figure 2. Hydraulic.

Hydraulic pump

"The hydraulic pump used to carry the fluid has many variations in its shape. The gear pump is the simplest form of a hydraulic pump. In a gear pump, a case involving two mesh gears.

The rotating action of these arts helps push the oil from inlet to outlet. The rotary fin pump is another type of hydraulic pump. In this type of hydraulic pump, the oil is pushed by means of a rotating beam, which still passes through a screw pump and the system." [4]

Figure 3. Progressive cavity pump

- **Hydraulic cylinders:**

"In some hydraulic machines, the hydraulic cylinder can be used to create movement. The pressure is created by the cylinder when the oil is pushed into it. The pressure created by the cylinder is exerted on a piston, which slides out. These pistons are connected to a set of various devices, including different levers." [4]

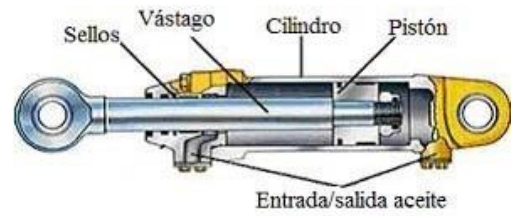

Ilustración 4. Cilindro hidráulico.

- **Hydraulic motor:**

"A hydraulic motor uses fluids in its operation and employs the science of hydraulics. The hydraulic motor is really a mechanical actuator that allows the conversion of hydraulic pressure into angular displacement and torque.

The hydraulic motor receives a fluid channeled into hydraulic tubes pressurized by the pump. The fluid is originally stored in a reservoir. An internal combustion engine contributes to the hydraulic pump unit of the fluid in the tubes that is most adopted for the hydraulic motor.

The liquid that flows in a form under pressure, rotates the engine, once it flows through it. The liquid, after flowing through the engine, returns to the reservoir. The cycle repeats like this, to keep the engine running"[4]

In practice, the OMM 151G0041 engine is used. The following table shows the main characteristics of the engine where:

Int: Intermittent work
Cont: Continuous work

Peak: Short duration full load work

Type			OMM
Motor size			**8**
Geometric displacement	cm³ [in³]		8.2 [0.50]
Max. speed	min⁻¹ [rpm]	cont.	1950
		int.¹⁾	2450
Max. torque	Nm [lbf-in]	cont.	11 [95]
		int.¹⁾	15 [135]
		peak²⁾	21 [185]
Max. output	kW [hp]	cont.	1.8 [2.4]
		int.¹⁾	2.6 [3.5]
Max. pressure drop	bar [psi]	cont.	100 [1450]
		int.¹⁾	140 [2030]
		peak²⁾	200 [2900]
Max. oil flow	l/min [gpm]	cont.	16 [4.2]
		int.¹⁾	20 [5.3]
Max. starting pressure with unloaded shaft	bar [psi]		4 [60]
Min. starting torque	at max. press. drop cont. Nm [lbf-in]		7 [60]
	at max. press. drop int.¹⁾ Nm [lbf-in]		10 [90]
Min. speed³⁾	min⁻¹ [rpm]		50

Figure 6. Features hydraulic motor OMM 151G0041

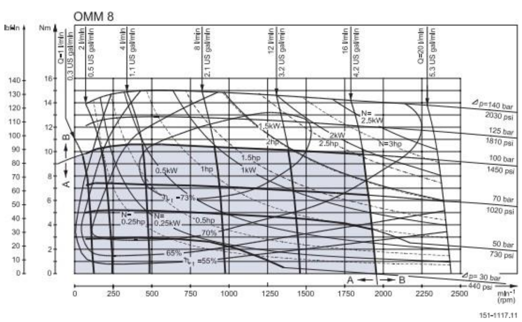

Figure 7. Curves characteristic hydraulic motor.

- **Hydraulic power:**

"To determine the hydraulic power developed by an engine, the flow rate must be measured using Equation 1.

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$$Q = \frac{Desplazamiento * Velocidad}{1000 * Rendimiento\ Volumétrico} \quad \text{Ec.1}$$

Where:

$\boldsymbol{Q\ Caudal}: l/min$

$\boldsymbol{Desplazamiento}: cm^3\ /revolución$

$\boldsymbol{Velocidad}: rpm$

It must be known with what pressure the liquid flows into the engine (High pressure) and the pressure with which the liquid goes to the storage tank (Low pressure)

The overall performance of a hydraulic pump is the product of its volumetric performance (theoretical flow ratio and experimental flow ratio) and mechanical performance (construction characteristics)." [5]

$$P = \frac{Q * (Alta\ presión\ - Baja\ presión) * G}{600}$$

Ec. 2

Where:

$\boldsymbol{G}: Rendimiento\ global$

$\boldsymbol{P}: kW$

8. MATERIALS:

To carry out the practice, the following materials are used:

- Simulation tool FluidSim Festo.
- Choke valve
- Hoses
- Hydraulic cylinder
- Hydraulic directional valves
- Hydraulic motor

9. METHODOLOGY:

The development of hydraulic sequences will be carried out, where elements such as cylinders, valves, engine, among others, will be used.

To perform the control of the sequences, it is necessary to decide the most appropriate configuration to implement, and that, of course, requires fewer elements, being more optimal for the development of the circuits. The design of the hydraulic circuit that will be mounted in the laboratory will be as follows:

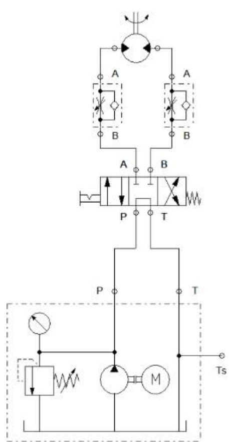

Figure 8. Drawing.

10. PROCEDURE:

- Perform the simulations to determine the correct configuration to use.
- Determine the necessary components to develop the practice.

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- Perform the assembly of a hydraulic circuit that allows to drive a hydraulic motor, by means of a choke valve vary the speed of rotation.
- Determine the hydraulic power developed by the engine. The displaced volume of the engine is approximately 8cm3. Use a tachometer to measure engine speed.

11. SIMULATIONS:

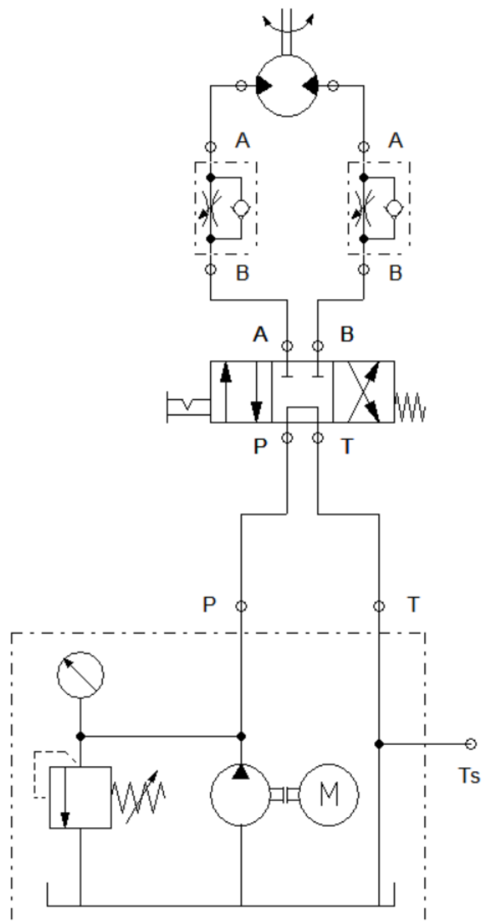

Figure 9: Simulation on FluidSim

Teniendo en cuenta la simulación, se obtiene las respectivas graficas de funcionamiento.

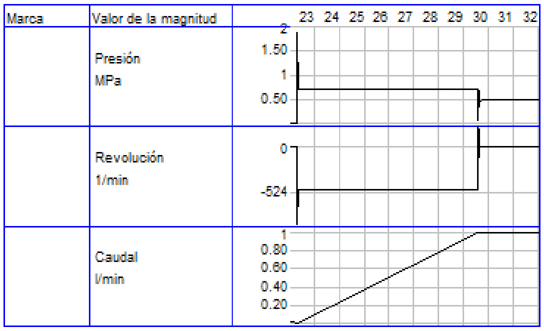

Figure 10: Graph in the simulation of Pressure, Revolution and Flow.

12. ANALYSIS OF RESULTS:

The hydraulic motor, which has a displaced volume of 8, was started at different pressures, this is achieved with the flow choke valve, to then measure the speed. These data are contained in Table 1.

Pressure (bar)	Speed (rpm)
4	292,3
6	365,7
8	477,8
10	530,1
12	652,1

Table 1: Motor speeds at different pressures.

Using equation 1 to find the flow rate when the pressure is 4 bar:

$$Q = \frac{8cm^3 * 292{,}3\,\frac{rev}{min}}{1000 * 1}$$

$$Q = 2{,}33\,\frac{litros}{min}$$

And the power, low pressure was 20psi=1.38 bar, for this practice, using equation 2:

$$P = \frac{2{,}33\,\frac{litros}{min} * (4\ bar\ - 1{,}38bar) * 1}{600}$$

$$P = 0{,}01kW = 10{,}1W$$

It takes the overall return as 100%. Making a generalized calculation for the flow rates and powers presented in each of the 5 test pressures, Table 2 contains these data:

Pressure (bar)	Flow (l/min)	Power (kW)
4	2,33	0,01
6	2,92	0,02
8	3,82	0,042
10	4,24	0,060
12	5,21	0,092

Table 2: Flow rate and power of the pump at different pressures.

La The power of the pump increases as the flow rate increases, and the flow rate in turn increases when the pressure also increases.

13. CONCLUSIONS

The power consumed by the motor is zero, since it is without load, and when it is without an external force that produces an effort on the shaft to the motor, the no resistance.

-The change of speed with respect to the change of pressure yields a linear relationship between these 2 variables, which can allow easy control in other applications.

14. BIBLIOGRAPHY:

[1] Software FluidSim

[2] Hydraulic motor and 4/3 Festo.

[3] Features of hydraulic systems

http://www.areatecnologia.com/que-es-hidraulica.htm

[4] Motor hidráulico y principales características. *http://fisica.laguia2000.com/dinamica-clasica/fuerzas/motor-hidraulico*

[5] UMNG Laboratory