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DESIGN AND ANALYSIS OF HYDRAULIC POWER PACK

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Abstract

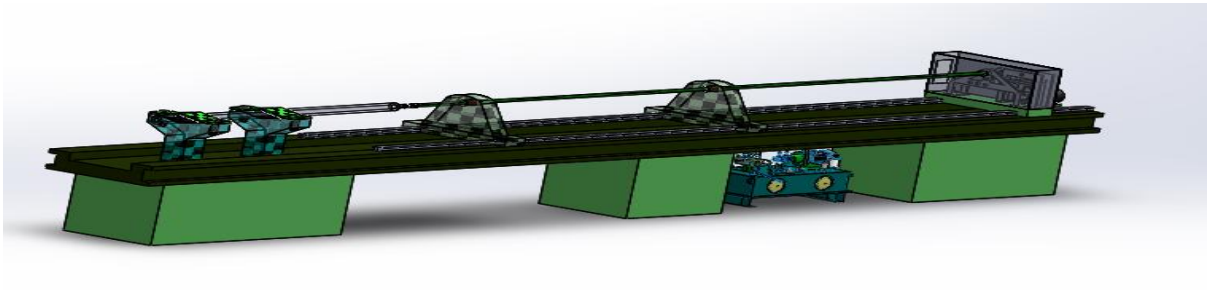
The project is aimed at the Design & Analysis of hydraulic power pack. This Hydraulic power pack is used to obtain the various motions of the honing machine, Clamping and unclamping is also done with hydraulic system. Hence versatility and reliability of hydraulics is prime importance. The power pack is an integral supply unit usually containing a pump, reservoir, relief valve and direction control valve, Pressure control valve. For the purpose of design of hydraulic power pack, the component are to be designed are pump, reservoir, heat exchanger and an electric motor. Hydraulic drives and controls have become more important due to automation and mechanization. Many of the modern and powerful machinery are controlled partly or completely by hydraulics. Hydraulic system is less complicated and has less moving parts. Today drive and control system engineering is inconceivable without hydraulics. Special emphasis is made on design of power pack in which the elements, maintenance aspects and trouble-shooting methods is dealt with. A lathe of one meter admits between centers is used for retro fitting. The main head stock and tail stock are replaced by work fixture and tool motor. The base of tail stock is retained and a geared motor of 60rpm is used for primary cutting motion. A special fixture is designed to hold a cylinder liner of 200mm bore.

INTRODUCTION

The word hydraulics is derived from the Greek word "hydro" means water. The term hydraulics means the transmission and control of forces and movement by means of fluid. The power pack is an integral power supply unit, which basically determines the working of the control unit. Power packs offer capacities, control options and configuration for virtually any application requirement. A wide variety of manifold options and choice of pumps enables customers to match any application requirement with a power pack that meets his system, at the same time ensuring cost effective operation and optimum productivity. A hydraulic power pack offers a simple method of introducing hydraulic Operation to individual machines, with flexibility of being adaptable to other duties.

It consists basically of an integral electrical motor, with associated tank. The pump or motor unit may be mounted on the tank or separately and packs are usually available in either horizontal or vertical configuration. Relief and check valves are normally incorporated on the tank. Hose assemblies are generally preferred to rigid piping for connecting the power pack to actuators. The hydraulic power packs consist of a reservoir / tank that house the hydraulic fluid, which is the working medium. The capacity of the tank may vary accordingly to the requirements. The reservoir is also equipped with an air breather at the top to maintain the pressure in the tank at the atmospheric pressure and filters the oil to 40 microns. Water was one of the most widely used hydraulic

fluid in early hydraulic machinery. It has the advantages of being inexpensive, readily available. Its disadvantages are that it is a poor lubricant, is corrosive to steel and iron, and cannot be used below 0°c unless additives are added. In spite of its disadvantages it is still used in large central hydraulic pressure systems such as in rubber plants and modelling plants.



Basic Analysis for work piece cylinder

• **Material for Honing Stone**	**Aluminium Oxide**
• **Material for Honing machine Frame**	**Cast Iron**
• **Material for Cylinder**	**Mild steel**

Material for cylinder

Mild Steel (Reason)

- ASTM A36 MILD (LOW CARBON STEEL)
- DENSITY 7800 KG/Cubic meter
- Syt 250 Mpa
- Induced Shear Stress 75 Mpa
- **Calculation**
- **Weight Calculation of Cylinder(Mild Steel with Density=7800 Kg/cu.m)**

Length=5 m , breath=200mm	**Weight=1224 Kg**
Length=4 m	**Weight=975 Kg**
Length=3 m	**Weight=741 Kg**
Length=2 m	**Weight=491 Kg**
Length=1 m	**Weight=241 Kg**

Therefore by using above formula p=q(0.414).ast/ak
Where q=specific stone contact pressure.(1.5N/mm sq)
Ast=total honing stone surface area(300 by 100)
Ak=piston area (taking piston diam as 160 mm, 20106 mm sq)
Therefore after calculation the hydraulic pressure comes out to be 9.2658 BAR
NOW AS WE ARE DESIGNING HEAVY DUTY HONING MACHINE
Therefore to rotate the honing tool we have to use the 30 hp motor as per the site of ohiotoolworks.com . lets specify the 30 hp motor.

Ac induction motor	High efficient
Type	RGZESD
H.P	30
A.M.P.S	35.0
R.P.M	1800
DUTY	CONTINOUS 40 DEG CELSIUS AMB
FRAME	286T
SERVICE FACTOR	1.15
VOLT	460
HERTZ	60
CLASS INSUL	F
NEMA DESIGHN	B
PHASE	3
WEIGHT	220 KG

To calculate hydraulic pressure for that the maximum force that the cylinder has to apply can be taken as (sum of all the weight that the cylinder has to push that is wt of motor whose ideal wt is 200 kg and the honing connecting rod and the honing tool and its approx weight goes to 18000 kg)

TO CAL PUSH AND PULL FORCES OF THE HYDRAULIC CYLINDER

BY USING FORMULA

PUSH =(PSI* 3.1415*BORE DIAM^2 / 4) lbs

PULL=(PSI*3.1415*(BORE DIAM ^{2}-DIAM OF PISTON^2)/4) lbs

Hence we get the push force of the cylinder as 38406 kg

And the pull force of the cylinder is 20815kg

Now to calculate the power pack that can give output power of 8 MPA OR MORE

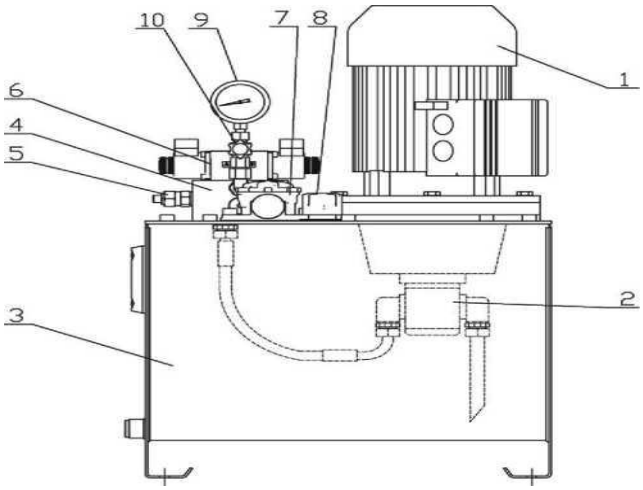
Type AH - Hydraulic characteristics - Tab.1

HENCE FOR 8 MPA WE HAVE AH 50 UNIT NOW LETS SEE WHAT IS AH 50 TYPE POWER PACK BELOW ARE MENTIONED ITS SPECIFICATION AND OTHER DETAILS

Pump displacement (cm^3/rev)	Flow rate at 1450 rpm [l/min]	Maximum pressure [MPa] with motor power of										Suggested
		0,37kW	0,55 kW	0,75kW	1,1kW	1,5kW	2,2kW	3kW	4kW	5,5kW	7,5kW	
1,17	1,7	12	18	22								
2,6	3,8	6	8	12	17	22						AH-20
4,16	6		5	7,5	11	14	21	23				
6,5	9,4		3,5	4,5	7	9,5	14	19	23			AH-35-
7,54	10,9			4	6	8	12	16	21	23		
8,4	12,2				5	7	10,5	14	19	20		
10,8	15,7				4	5,5	8	11	15	15	23	AH-50-
14,4	20,9						6	8	11	13	20	
16,8	24,4						5	7	9	11	17	
19,2	27,8							6	8	9	15	AH-75-
22,8	33,1							5	7	8	13	
26,2	38								6	6,5	11	
32,3	46,8								5	5,5	9	
38,5	55,8									5	7,5	AH-100/
43,4	63										6,5	AH-150-
47,2	68,4										6	
50,9	73,8										5,5	

Design:

In standard version, AH power pack is composed of vertical motor-pump unit, steel or aluminium reservoir with return filter (with visual clogging indicator), flow and pressure control valves, and solenoid operated directional valve. In order to meet requirements of specific hydraulic systems, standard version may be modified by using additional valves and blocks.



Basic version of AH type power pack composed of:
1 - electric motor
2 - hydraulic gear pump
3 - oil tank
4 - valve manifold
5 - relief valve
6 - solenoid operated directional control valve(NG6 or NG10)
7 - return filter with visual clogging indicator
8 - filling plug with air filter
9 - pressure gauge
10 - pressure gauge's shut-off valve

Type AH - Basic hydraulic characteristics

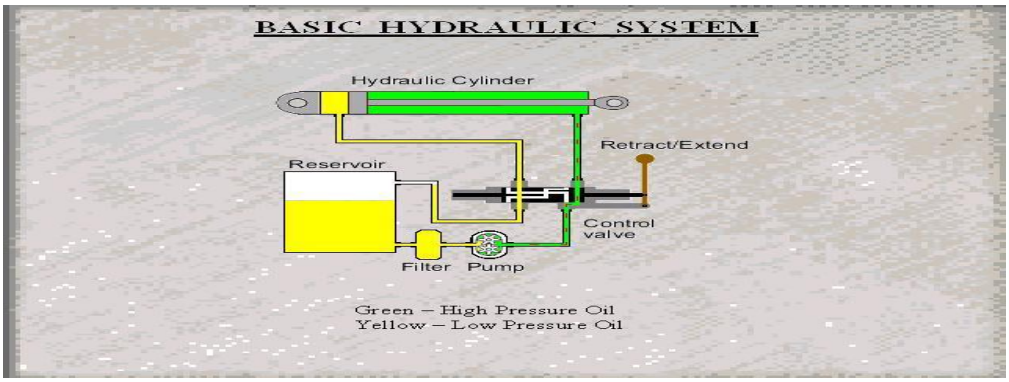
Installation position	Horizontal, with vertical motor axis
Ambient temperature	-20°C - +50°C
Recommended temperature	30°C - 50°C
Fluid temperature	-15°C-70°C
Fluid	Mineral oil type HLP
Recommended viscosity	20mm ^{2}/s - 100mm^2/s
Degree of fluid contamination	Class 21/18/15 according to ISO 4406
Electric motor	4-pol., 230/400 V, 400/690 V -50Hz
Pump type	Gear pump
Port sizes	G3/8", G1/2", G3/4"
Tank capacity	Depending on duty cycle and flow level

Type AH - Standard three-phase motors - Tab.2

Motor power	0,37 kW	0.55 kW	0,75 kW	1,1 Kw	1,5 kW	2,2 kW	3kW	4kW	5,5kW	7,5kW
Nominal voltage	230/400V 50Hz*								400/690V 50 Hz*	
Motor size	71		80		90		100	112		132
Rated speed [rev/min]	1370	1395	1395	1415	1420	1420	1420	1440	1455	1455
Dimension L $_{max}$	225	252	252	299	299	331	331	352	396	396

Type AH - Standard gear pumps - Tab.3

Type	XV-1P/1,2	XV-1P/2,6	XV-1P/3,8	XV-1P/4,3	XV-1P/6,5	XV-1P7,8	XV-2P/09	XV-2P/11	XV-2P/14
Displacement [cm^3/rev]	1,17	2,6	3,64	4,16	6,5	7,54	8,4	10,8	14,4
Type	XV-2P/17	XV-2P/19	XV-2P/22	XV-2P/26	XV-3P/32	XV-3P/38	XV-3P/43	XV-3P/47	XV-3/P51
Displacement 3	16,8	19,2	22,8	26,2	32,3	38,5	43,4	47,2	50,9



ACTUAL WORK DONE

The working of a power pack commences when the pump is initialized with the help of an electric motor coupled to it. The oil is pumped from the reservoir along the suction line through a suction strainer with a capability to retain the foreign particles up to 149 microns. From the suction line the oil is forced in to the pressure line through the pump at 35 bars. There is provision to measure the pressure, with the help of a pressure gauge. An isolator is used to measure the pressure immediately in any line. When the set of pressure is reached, the fluid moves to the cylinder present at the fixture (clamp). The hydraulic energy of the fluid is converted back to the mechanical energy by the cylinder. According to the direction of the energizing of the solenoid valve, the linear movement of the clamps (clamping and unclamping) is controlled. When the solenoid valve is energized in reverse, unclamping of the work piece occurs. There is a return line provided so that the used fluid may be utilized again. Due to the friction losses, total energy is not converted into the useful work so a part is converted into the heat. So, a heat exchanger is incorporated. The return line filter has a return capacity of 10 microns

Design Components

A large, durable hydraulic power unit built for functioning under a range of environmental conditions will have numerous design characteristics distinct from a typical pumping system. Some of the standard design features include:

- **Accumulators:** These are containers that can be attached to the hydraulic actuators. They collect water from the pumping mechanism and are intended to build and maintain fluid pressure to supplement the motor pumping system.
- **Motor Pumps:** A hydraulic power unit can be equipped with a single motor pump, or multiple devices each with their own accumulator valve. With a multiple pump system, usually only one operates at a time.
- **Tanks:** The tank is a storage unit designed with enough volume for the fluid in the pipes to drain into it. Likewise, actuator fluid may sometimes need draining into the tank.
- **Filters:** A filter is typically installed along the top of the tank. It is a self-contained bypass unit, with its own motor, pump, and filtering apparatus. It can be used to fill or empty the tank by activating a multi-directional valve. Because they are self-contained, filters can often be replaced while the power unit is functioning.

- **Coolers and Heaters:** As part of the temperature regulation process, an air cooler can be installed near or behind the filter unit to prevent temperatures from rising above operational parameters. Likewise, a heating system, such as an oil-based heater, can be used to elevate temperatures when necessary.
- **Power Unit Controllers:** The hydraulic controller unit is the operator interface containing power switches, displays, and monitoring features. It is necessary for installing and integrating a power unit into a hydraulic system and can usually be found wired into the power unit.

Operating Process

When a hydraulic power unit begins functioning, the gear pump pulls hydraulic fluid out of the tank and moves it into an accumulator. This process continues until the pressure within the accumulator reaches a predetermined level, at which point a charging valve switches the pumping action to begin circulating fluid. This causes the pump to release fluid through a charging valve back into the tank at minimal pressure. A special one-way valve keeps fluid from flowing out of the accumulator, but if the pressure drops by a significant amount, the charging valve reactivates and the accumulator is refilled with fluid. Farther down the line, a reduced-pressure valve regulates the flow of oil moving to the actuators.

If the accumulator is equipped with a fast-stroking device, it can be connected to other accumulators to allow them to charge pressure as well. Often, an automatic thermostat or fan will be included to help alleviate rising temperatures. If the fluid in the system begins to overheat, a temperature switch can shut the motor-pump off, which can also help refill the tank if its fluid level is too low. If the hydraulic power unit has multiple motor pumps, a flow switch can have them alternate in case of reduced fluid supply. Pressure switches can be used to regulate accumulator pressure and a monitoring system can alert operators when pressure has dropped too low, elevating the risk of power unit failure.

FINAL CALCULATION FOR HEAVY DUTY HONING MACHINE

WORKPIECE	**A36 MILD (LOWCARBON STEEL)**
DENSITY OF WORKPIECE	**7800 KG/CUBIC METER**
FRAME OF HONING MACHINE	**CAST IRON**
DENSITY OF CADT IRON	**8000 KG/ CUBIC METER**
HONING STONE	**ALUMINIUM OXIDE**
DIMENSION OF TOOL	**0.3 M**
TOOL RPM	**175 (VARIABLE ACC TO NEED)**
FEED OF TOOL	**5 M / MIN (VARIABLE)**
CUTTING PRESSURE	**1.5 N/MM^2**
GRIT SIZE	**80 -600**
LENGTH OF WORKPEICE	**5 M**
WT OF WORKPEICE	**1224 KG**
ACTUATOR	**FLUID POWER LONGITUDNAL**
HYDRAULIC PRESSURE	**9.2 BAR**
POWER PACK	**8 MPA**
MOTOR TO ROTATE TOOL	**30 HP**
RPM OF MOTOR	**1800 RPM**

RESULTS & CONCLUSION:

The result of this entire hydraulic power pack which is designed in the SOLID WORKS is that we have successfully designed hydraulic power pack in SOLID WORKS.

- This power pack i.e. designed in SOLID WORKS is accurate and efficient.
- And we have successfully analysed the various stress that are developed in the power pack and heavy duty industrial honing machine.
- With this power pack the surface finish obtained by the honing machine is 0.3 micro meter.
- The optimum feed to get the best possible surface finish is identified as 5 m/min.
- The finish in dry honing is not satisfactory. Hence, as a rule, medium is essential for this process.
- The tool is protected from over loads by the relief valve used in hydraulic circuit.
- The hydraulic line pressure is directly proportional to the metal removal rat
- As the pressure increases, feed increases linearly.

- This method yields best possible surface finish at minimum cost.

When coarse grain abrasive is used the MRR is equivalent to grinding Interpretation of the work has been analysed using design expert software and error is only 0.01% where less than 0.05% indicates model terms are significant.

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