To: P. Lin, P. Broberg and Mr. Joe Fortney

From: Gary Atchison

Date: 2/22/10

Re: Forming Die Test Press
Design Project Report

Report Outline

- Report Summary
- Problems and Corrections
- Status of the Machine
- Timeline for Completion
- Supporting Information
    - System Block Diagram
    - Project Gantt Chart
    - Hydraulic Power Unit Calculations
    - Motion Controller Information Calculations

Report Summary

Gentlemen, what you will find in the following report are updated screen shots of my project Gantt chart, the system calculations for the hydraulic power unit required for the machine and the MMC Standalone control setup file calculations. Also is a brief description of any issues that have come up along the way and their corrections, what is the status of the machine and what is left to be done. I would like to note that this machine has had an Ethernet module installed on the MMC Standalone control that will allow us to connect remotely from Marion with the machine in Germany. This will allow us to be able to modify and download control programs if needed without making a trip to Germany.

Problems and Corrections

The original electrical design of the machine was done a year ago before the hydraulic system was designed so the intention was to use the hydraulic system design of the first test press machine. It did not have a cooling fan motor on the hydraulic unit. Instead it used 2 electrical enclosure cooling fans mounted around the hydraulic unit to help cool it. Because we wanted to improve the design of the hydraulic power unit a cooling fan was included so we had to update the electrical design to include the hydraulic power unit cooling fan.

Another problem that has arose because of the changing the hydraulic power unit design from that of the original test press design is with the new design we changed from a hydraulic servo valve which uses a current input to a proportional valve which uses a voltage input. Because of this, the electrical system has been updated which requires another 24V power supply for the proportional valve and the removal of the VC2124 which was going to be used to convert the analog +/- 10V signal to a current which the servo valve used. We are currently awaiting the arrival of the power supply so it can be installed. At that time we will remove the VC2124 converter and complete the wiring as necessary.

There was some confusion when parts were ordered for the hydraulic system and the wrong length cylinder and linear transducer were ordered. Parts were ordered for a 10 inch cylinder instead of a 15 inch cylinder. A 15 inch cylinder and a 15 inch MTS linear transducer have been ordered and are expected to arrive any time.

Status of the Machine

Presently the machine has been built allowing the installation of the hydraulic power unit and the electrical enclosure. Hoses are being routed to length so that they can be crimped. The safety pin cylinder has been installed and guards are in the process of being installed. Most of the electrical installation has been done but does not include the installation of the outputs solenoids for air control. The MS Project Gantt chart has been updated to reflect the recent progress on the machine and a document containing the calculations for the hydraulic power unit and the motion control system has been created.

What is left to be done is to complete the hydraulic hose installation and the machine wiring at which time we can begin installing the programs for the operation of the machine. Once these are complete we can begin testing and debug of the various systems. Once testing and debug are complete we can fully run the machine to make sure that all requirements have been met.

Time Line for Completion

Present: 2/19/10
Finish electrical and hydraulic installation: 3/1/10
Finish the installation of interlocks and guards: 3/1/10
Testing and Debug complete by: 3/15/10
Ship the Machine: 3/15/10 to 4/15/10 depending on machine schedule

Supporting Information

What you will find in the following information is the information for the system design, including hydraulic and motion control calculations. These will be included in the final report at the end of the semester. You will also find a block diagram that shows the basic system components and how they are connected to create a complete system. The only updated Gantt chart that will be shown are those with recent activity and those to yet be completed. I will begin on the next page with the System Block Diagram and I will provide subheadings for clarity.

System Block Diagram:

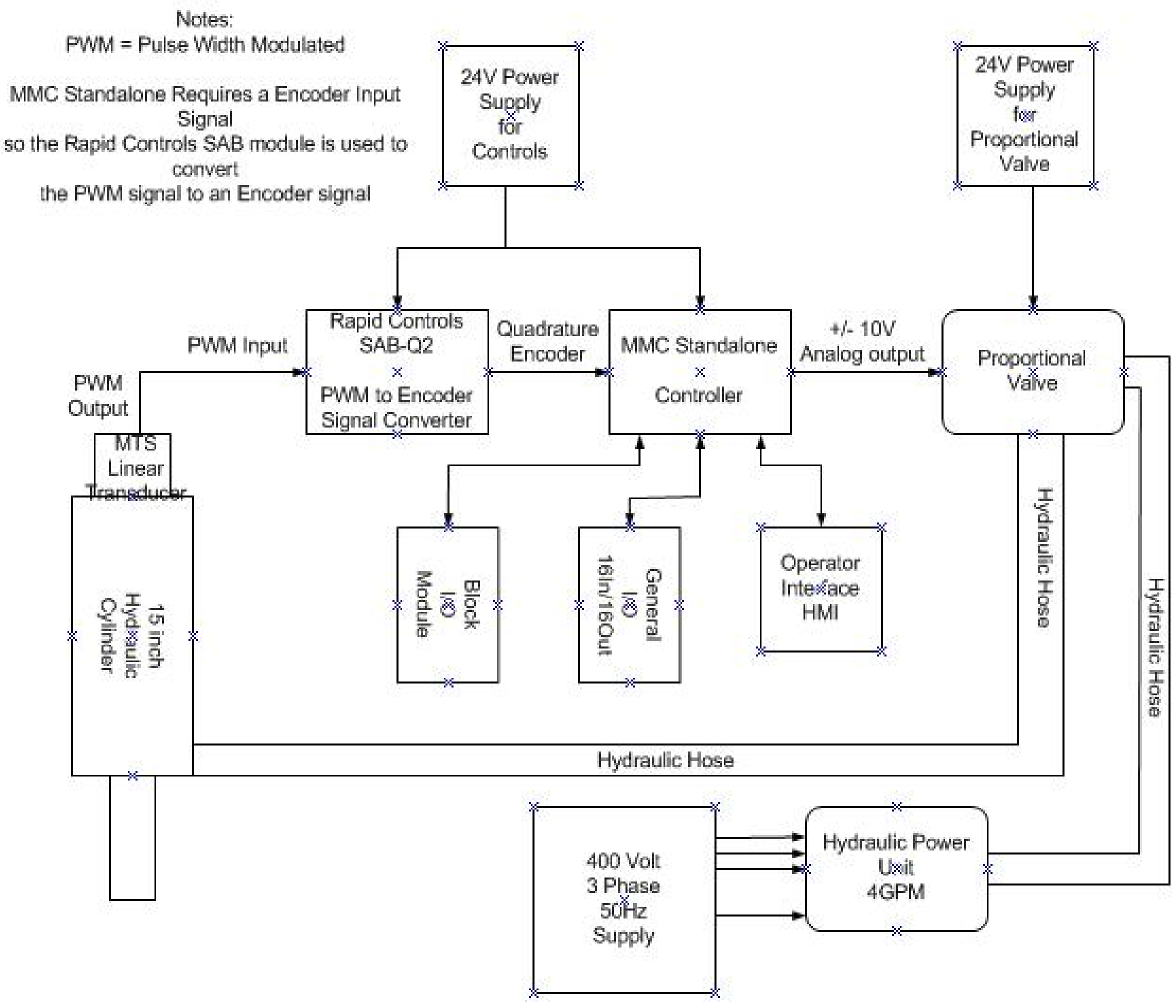


Figure 1 System Block Diagram showing interconnectivity of all components

Gantt Charts:

	ℹ	Task Name	Duration	Start	Finish	Resource Names
1	✓	⊟ **Analysis**	**30 days**	**Mon 2/9/09**	**Thu 3/19/09**	
2	✓	⊟ **Analyze Existing Program**	**1 day**	**Mon 2/9/09**	**Mon 2/9/09**	**Gary Atchison,Roger Beck**
3	✓	Review Controls and I/O Opertion in Existing Sequential Code	1 day	Mon 2/9/09	Mon 2/9/09	Gary Atchison
4	✓	⊟ **Analyze Existing Controls**	**1 day**	**Mon 2/9/09**	**Mon 2/9/09**	**Gary Atchison[18%],Roger Beck**
5	✓	Review Existing Controls Usage and Wiring Schematics to determine what is needed	1 day	Mon 2/9/09	Mon 2/9/09	Roger Beck,Gary Atchison
6	✓	Compare Delta Computer System with G&L Controls MMC to determine brand of Controls	1 day	Mon 2/9/09	Mon 2/9/09	Roger Beck,Gary Atchison
7	✓	⊟ **Order New Control System**	**30 days**	**Mon 2/9/09**	**Thu 3/19/09**	**Gary Atchison[17%],Roger Beck**
8	✓	Place order for control system components and electrical parts	30 days	Mon 2/9/09	Thu 3/19/09	Gary Atchison,Roger Beck
9	✓	⊟ **Developing the New Control System**	**38 days**	**Wed 2/11/09**	**Wed 4/1/09**	**Roger Beck,Gary Atchison**
10	✓	Create New Electrical Drawings	5 days	Tue 2/24/09	Mon 3/2/09	Roger Beck
11	✓	Create New Ladder Program	21 days	Wed 2/11/09	Tue 3/10/09	Gary Atchison
12	✓	Mock Up Control System to test Communication	1 day	Wed 4/1/09	Wed 4/1/09	Gary Atchison
13	✓	Progress Report 1	1 day	Thu 9/10/09	Thu 9/10/09	Gary Atchison
14	✓	Progress Report 2	1 day	Thu 10/1/09	Thu 10/1/09	Gary Atchison
15	✓	Progress Report 3	1 day	Thu 10/22/09	Thu 10/22/09	Gary Atchison
16	✓	Progress Report 4 Initial Proposal and 10 minute presentation	1 day	Thu 11/19/09	Thu 11/19/09	Gary Atchison
17	✓	Final ECET 490 Report and Presentation	1 day	Thu 12/10/09	Thu 12/10/09	Gary Atchison
18	✓	⊟ **Develop and Order Hydraulic System**	**62 days**	**Thu 10/22/09**	**Tue 1/12/10**	**Joe Fortney,AJ Lindvall**
19	✓	Create New Hyd Sytem Design	18 days	Thu 10/22/09	Fri 11/13/09	AJ Lindvall,Joe Fortney
20	✓	Order Hyd System	45 days	Fri 11/13/09	Tue 1/12/10	AJ Lindvall
21		⊟ **Building the Press and Installing Components**	**25.38 days**	**Mon 1/11/10**	**Thu 2/11/10**	**Assembly Department,Electrical Department**
22	✓	Paint the machine structure	1 day	Mon 1/25/10	Mon 1/25/10	Assembly Department
23		⊟ **Build the Press**	**14.75 days**	**Mon 1/25/10**	**Thu 2/11/10**	**Assembly Department**
24	✓	Assemble the Forming Head	1 day	Mon 1/25/10	Mon 1/25/10	Assembly Department
25	✓	Install Brass Forming Head to Guide Pin Bushings	1 day	Fri 2/5/10	Fri 2/5/10	Assembly Department
26		Install Guards and Interlocking Mechanisms	2 days	Mon 2/8/10	Tue 2/9/10	Assembly Department
27		Install air solenoids and Safety Axis Lock Cylinders	2 days	Tue 2/9/10	Wed 2/10/10	Assembly Department
28		Install Hydraulic Cylinder and Linear Transducer	1 day	Tue 2/9/10	Tue 2/9/10	Assembly Department
29		Install Hydraulic Hoses, Check Valves any remaining components	2 days	Wed 2/10/10	Thu 2/11/10	Assembly Department
30		⊟ **Install Electrical Components**	**10.56 days**	**Mon 1/11/10**	**Fri 1/22/10**	**Electrical Department**
31	✓	Install Electrical Components such as Switches and Relays	2 days	Mon 1/11/10	Tue 1/12/10	Electrical Department
	ℹ	Task Name	Duration	Start	Finish	Resource Names
32	✓	Added Cooling Fan Output to Ladder code and Drawings	1 day	Fri 1/22/10	Fri 1/22/10	Gary Atchison,Roger Beck
33	✓	Install Controls Components such as MMC, Ethernet Module, SAB, I/O Blocks	1 day	Wed 1/13/10	Wed 1/13/10	Electrical Department
34	✓	Install Heat Controls	1 day	Thu 1/14/10	Thu 1/14/10	Electrical Department
35	✓	Install Operator interface	1 day	Thu 1/14/10	Thu 1/14/10	Electrical Department
36		Run and attach all wiring	3 days	Thu 1/14/10	Mon 1/18/10	Electrical Department
37	✓	⊟ **Progress Report Due January 25, 2010**	**1 day**	**Mon 1/25/10**	**Mon 1/25/10**	**Gary Atchison**
38	✓	Updated Progress Report Due by 5:00pm 1-25-10	1 day	Mon 1/25/10	Mon 1/25/10	Gary Atchison
39	✓	Updated Flow Diagrams for clarity, created paint documents and inserted into the proposal	1 day	Mon 1/25/10	Mon 1/25/10	Gary Atchison
40	✓	Added Summary, updated Table of Contents, added departments to Resources	1 day	Mon 1/25/10	Mon 1/25/10	Gary Atchison
41	✓	Updated the MS Project Gantt Chart	1 day	Mon 1/25/10	Mon 1/25/10	Gary Atchison
42	✓	⊟ **Finalized Report Due February 1, 2010**	**1 day**	**Mon 2/1/10**	**Mon 2/1/10**	**Gary Atchison**
43	✓	Progress Report #1 Phase II Due by 5:00pm 2-1-10	1 day	Mon 2/1/10	Mon 2/1/10	Gary Atchison
44	✓	Update, Breakdown further the MS Project Gantt Chart Information	1 day	Mon 2/1/10	Mon 2/1/10	Gary Atchison
45	✓	Add summary for any new changes and or modifications, review requirments	1 day	Mon 2/1/10	Mon 2/1/10	Gary Atchison
46	✓	Design Report (2nd Report) Due by 5:00pm 2-22-10	1 day	Mon 2/9/09	Mon 2/9/09	Gary Atchison
47		⊟ **Installing Hydraulics and Starting Up the Machine**	**308.06 days**	**Mon 2/9/09**	**Fri 3/19/10**	**Assembly Department**
48	✓	Install Hydraulic System to the Machine	3 days	Mon 2/15/10	Wed 2/17/10	Assembly Department
49		⊟ **Setup New Control System**	**308.06 days**	**Mon 2/9/09**	**Fri 3/19/10**	**Gary Atchison**
50		Download Operator Interface Program	1 day	Mon 3/1/10	Mon 3/1/10	Gary Atchison
51		Download the machine program (Ladder)	1 day	Mon 3/1/10	Mon 3/1/10	Gary Atchison
52		Establish Communication with MMC remotely using PicPro for Internet Downloading	1 day	Mon 3/1/10	Mon 3/1/10	Gary Atchison
53	✓	Figure out Axis Setup Data for Motion Control (Accel, Decel, Velocity and Head Open Positions)	3 days	Mon 3/8/10	Wed 3/10/10	Consultant,Gary Atchison
54		Test Operator Interface Communication (Is it communicating with the ladder)	1 day	Tue 3/2/10	Tue 3/2/10	Gary Atchison
55		Test heat Control and setup parameters for the heat	1 day	Wed 3/3/10	Wed 3/3/10	Gary Atchison
56		⊟ **Test I/O Operation**	**1 day**	**Mon 2/9/09**	**Mon 2/9/09**	
57		Solenoid Operation (Top Die Air, Bottom Die Air)	1 day	Mon 2/9/09	Mon 2/9/09	
58		Pilot Light Operation (Power On, Run Mode, Manual Mode, Lock Pins Retracted, Lock Pins Extended)	1 day	Mon 2/9/09	Mon 2/9/09	
59		⊟ **Test Safety Systems (Guards)**	**2.06 days**	**Thu 3/11/10**	**Fri 3/12/10**	**Gary Atchison**
60		Test Guard Operation	1 day	Thu 3/11/10	Thu 3/11/10	Gary Atchison
61		Test Palm Button Operation	1 day	Thu 3/11/10	Thu 3/11/10	Gary Atchison
62		Test Operation of the Auto/Manual Mode Switch	1 day	Thu 3/11/10	Thu 3/11/10	Gary Atchison

		Task Name	Duration	Start	Finish	Resource Names
63		Can we only start the hydraulics in Manual Mode using the Simultaneous Press of the Palm Buttons?	1 day	Thu 3/11/10	Thu 3/11/10	Gary Atchison
64		Can the accumulator only be charged when the guards are closed?	1 day	Fri 3/12/10	Fri 3/12/10	Gary Atchison
65		Does the accumulator only charge in Auto Mode?	1 day	Fri 3/12/10	Fri 3/12/10	Gary Atchison
66		Do the safety Pins engage when the sliding guard door is opened?	1 day	Fri 3/12/10	Fri 3/12/10	Gary Atchison
67		**Test the 8 Operations of the machine as described in the flow diagrams**	**3.13 days**	**Mon 3/15/10**	**Wed 3/17/10**	**Gary Atchison**
68		Locking Pins Operation	1 day	Mon 3/15/10	Mon 3/15/10	Gary Atchison
69		Going to Start Position	1 day	Mon 3/15/10	Mon 3/15/10	Gary Atchison
70		Hydraulic Startup	1 day	Mon 3/15/10	Mon 3/15/10	Gary Atchison
71		Homing the Machine	1 day	Tue 3/16/10	Tue 3/16/10	Gary Atchison
72		Going to Start Position based on the Program Selected (1-4) from the HMI	1 day	Tue 3/16/10	Tue 3/16/10	Gary Atchison
73		Cycle Start (Machine Start)	1 day	Tue 3/16/10	Tue 3/16/10	Gary Atchison
74		Manual movement of the head (Jogging)	1 day	Wed 3/17/10	Wed 3/17/10	Gary Atchison
75		Heat Control	1 day	Wed 3/17/10	Wed 3/17/10	Gary Atchison
76		Test Motion Control and perform debug of motion control until proper control is established	2 days	Thu 3/18/10	Fri 3/19/10	Gary Atchison
77		Test functionality of the overall systems for proper operation (All systems working together)	1 day	Fri 3/19/10	Fri 3/19/10	Gary Atchison
78		Do we meet the requirements for Safety, EC, Electrical and System	1 day	Fri 3/19/10	Fri 3/19/10	Gary Atchison
79		System Construction and Unit Testing Report (3rd Report)	1 day	Mon 3/22/10	Mon 3/22/10	Gary Atchison
80		First Testing Report Due 5:00pm 4-5-10 (4th Report)	1 day	Mon 4/5/10	Mon 4/5/10	Gary Atchison
81		Second Testing Report Due 5:00pm 4-12-10 (5th Report)	1 day	Mon 4/12/10	Mon 4/12/10	Gary Atchison
82		**Progress Report and Design Review**	**14.63 days**	**Tue 4/13/10**	**Fri 4/30/10**	
83		Final Report Writing	4 days	Tue 4/13/10	Fri 4/16/10	Gary Atchison
84		Final Project and Presentation	5 days	Mon 4/26/10	Fri 4/30/10	Gary Atchison

Figure 2 Gantt Chart updated to show recent and future activity

Hydraulic Power Unit Calculations:

The following given parameters will be used to make hydraulic calculations to simulate a production speed of 40 SPM:

Time to Retract = 350ms
Time to Extend = 350ms
Closed Dwell = 500ms

Note:
Because this machine does not run in a continuous mode, open dwell is not considered in the calculation for head speed. Time to retract plus time to extend plus closed dwell as noted yield a 50 SPM machine rate. If we added an open dwell of 300ms then it would be equal to a 40SPM machine.

Head Open Position 11.375 inches **–** Die Shut Height 7.25 inches = 4.125 inch head stroke

Forming Pressure required = 20,000 pounds forming force

Head weight with components (HW) = 1250 pounds head + 110 pounds components = 1360 pounds

Friction Force (FF) = .24*HW*cos(0°) = .24*1360*1 = 326.4 pounds

The pages following are the calculations to be used in the development of the Forming Die Test Press based on the above given conditions:

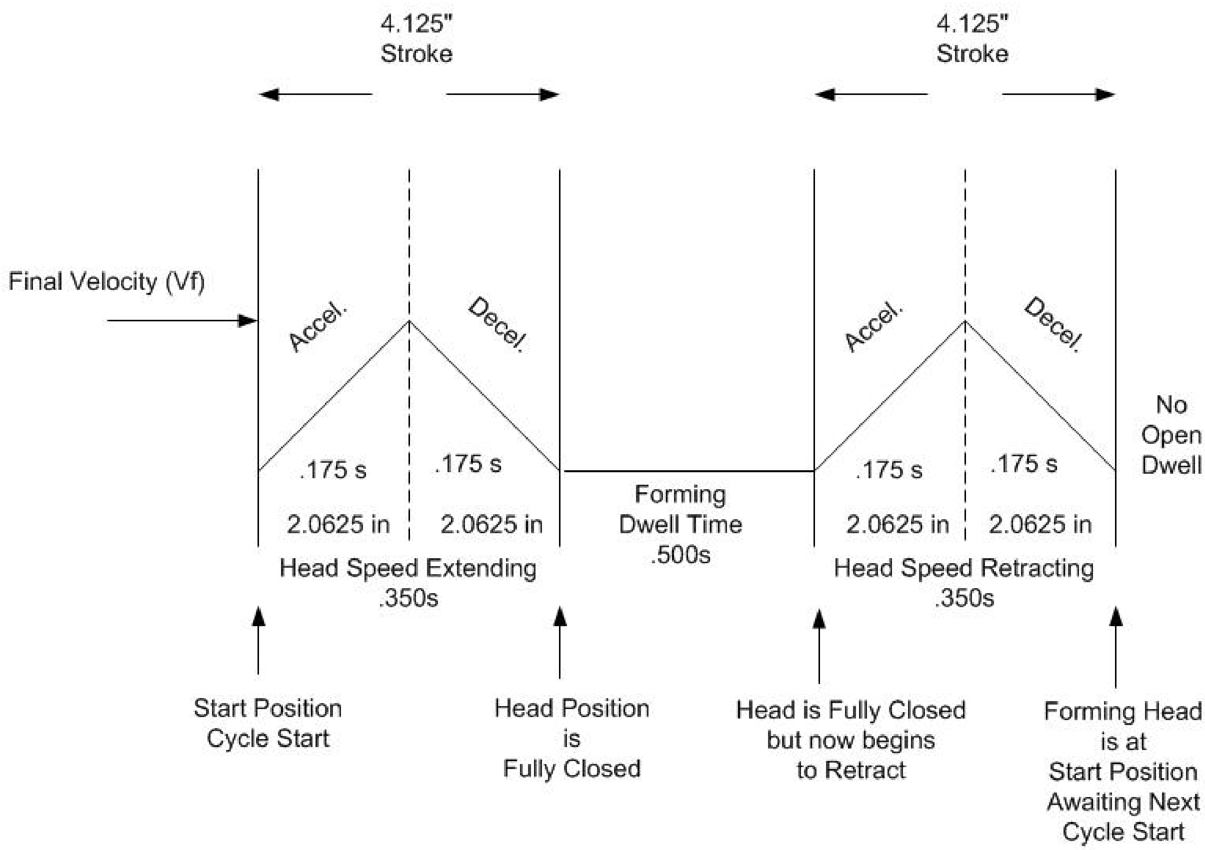
$AverageVelocity(Va) = 4.125 inches / .350 ms = 11.78 inches / second$

$FinalVelocity(Vf) = 2 * S \div t = (2 * 2.0625 inches) \div .175 \sec = 23.6 inches / second$

Using the distance and time under acceleration

Where S = Distance moved in inches = *2.0625 inches*

t = Time of acceleration = *.175 seconds*



Maximum Oil Flows:

Cylinder Bore = 3.25 inches

Cylinder Rod = 2 inch diameter

$CRA = CylinderRodArea = \pi * r^2 = 3.14 * 1.0^2 = 3.14 inches^2$

$CPAE = CylinderPistonAreaExtending = \pi * r^2 = 3.14 * 1.625 inches^2 = 8.3 inches^2$

$CPAR = CylinderPistonAreaRetracting = CPAE - CRA = 8.3 inches^2 - 3.14 inches^2 = 5.16 inches^2$

Oil Flow to Extend (OFE):

$OFE = CPAE * Vf = (8.3 in^2 * 23.6 in / \sec) = (195.9 in^3 / \sec) * (60 \sec/\min) =$

$(11754 in^3 / \min) / (231 in^3 / gal) = 50.9 gal / \min$

Oil Flow to Retract (OFR):

$OFR = CPAR * Vf = (5.16 inches^2 * 23.6 in / \sec) = (121.8 inches^3 / \sec) * (60 \sec/\min) =$

$(7308 inches^3 / \min) / (231 inches^3 / gal) = 31.6 gal / \min$

Hydraulic Oil Pressure Required to generate 20,000 pounds of forming force (HOPR):

$$HOPR = For\min gForce\operatorname{Re}quired / CPAE = 20000/8.3inches^2 = 2410\,pounds/inches^2$$

Weight of the Head and Components (HW) + Friction Force (FF)

HW + FF = 1360 pounds + 326.4 pounds = 1686.4 pounds

Find the amount of hydraulic pressure required to accelerate the head upward (PAHU):

To accelerate the 1686.4 pounds of the head at a production speed: "Use the formula"

a = acceleration rate
S = distance moved in inches
t = time of acceleration in seconds

$$a = (2 * S)/t^2$$

$$a = (2 * 2.0625inches)/.175\sec^2 = 134.7inches/\sec^2$$

Convert acceleration to feet/sec:

$$a/12inches = (134.7inches/\sec^2)/12 = 11.23\,feet/\sec^2$$

As well as knowing acceleration we also need to know (R) which is the Resultant Force On the Body. To find (R) use the following formula:

R = Resultant Force on the Body
w = HW + FF
g = Gravitational Force (32.16 feet/sec^2) or (9.81meters/sec^2)
a = acceleration rate in feet/sec^2

$$R = (w/g) * a = 1686.4\,pounds/(32.16\,ft/\sec^2) = 52.4\,footpound/\sec^2$$

$$(52.4\,footpound/\sec^2) * (11.23\,ft/\sec^2) = 587.9\,pounds$$

$$W = R + w = 587.9\,pounds + w = 587.9 + 1686.4\,pounds = 2274.3\,pounds$$

To finish finding hydraulic pressure need to accelerate the head upward:
Use the flowing formula for Pressure to Accelerate Head Upward (PAHU):

$$PAHU = W/CPAR = (2274.3\,pounds)/(5.16inches^2) = 441\,pounds/in^2$$

Note:
Accumulator Pressure must be greater than or equal to the Forming Pressure (HOPR), which is 2410 pounds/inch^2 because pressure is required from the accumulator for movement of the forming head.

To find the amount of pressure required for the accumulator pre-charge we must know and do the following:

1) The largest volume of oil taken from the accumulator will be at the maximum amount of head stroke (HS) which is:

Four head open positions will be needed:
20.375 inches
17.375 inches
14.375 inches
11.375 inches

Two different shut heights (closed die height) will be used for the dies:
12 inch
7.25 inch

12 inch shut height will be used with the 20.375 inch and 17.375 inch Machine Head Open Position

7.25 inch shut height will be used with the 14.375 inch and 11.375 inch Machine Head Open Position

The greatest head travel is realized when using the 20.375 inch Head Open Position with the 12 inch shut height die, so;

$$HS(HeadStroke) = 20.375inch - 12inch = 8.375inches$$

2) The oil volume required from the accumulator to move the head 8.375 inches is found by the following:

Extending:

$$HS * CPAE = 8.375inch * 8.3in^2 = 69.5in^3$$

This 69.5inches^3 is compressed to 2410 pounds/inch^2
We need to know that .5% oil volume compression/1000 psi is:
$2410psi/1000psi/.005 = 2.41*.005 = 1.205\%$ **or .01205**

Now we can finish finding oil volume from the accumulator (OFA) to move the head 8.375 inches

$$OFA = (HS * CPAE)*.01205 = .84in^3 + (HS * CPAE) = 70.34in^3$$

$$OFA = 69.5*.0125 = .84 + 69.5 = 70.34in^3$$

Now we can find the amount of pressure required for the accumulator pre-charge

Use the equation:

$P_1 * V_1 = P_2 * V_2$

Where:

P_1 = *HOPR* = $2410\, pounds/inches^2$

P_2 = *Accumulator Pre-charge Pressure*

V_1 = *Rated Gas Volume = 1124in*^{3}

V_2 = V_1 *– OFA = 1124in*^{3}*-70.34in*^{3} *= 1053.7in*^{3}

$P_2 = (P_1 * V_1)/V_2 = (2410 * 1124)/1053.7 = 2708840/1053.7 = 2570.8\, psi$ Accumulator Pressure

PVR = Pump Volume Required at a 4.125" stroke

P = Pump = 4gallons/minute

Stroke = 4.125inches

A = Cylinder Volume Extending

B = Cylinder Volume Retracting

$A = CPAE * Stroke = 8.3 inches^2 * 4.125 inches = 34.24 inches^3$

$B = CPAR * Stroke = 5.16 inches^2 * 4.125 inches = 21.29 inches^3$

$PVR = A + B = 34.24 + 21.29 = 55.53 inches^3$

PVR Converted to gallons = .24 gallons

TTR = Time Required to Refill the Accumulator at a 4.125" stroke

TTR = .24 gallons required at .066 gallons/second (4gallonsl/minute) = 3.64 sec

M = Motor Size Required

P = Pump = 4gallons/minute

P_2 = 2571pounds/inches^2

K_1 = 1714

K_2 = .85

M = $\dfrac{P_2 * P}{K_1 * K_2} = \dfrac{2571 * 4}{1714 * .85} = 7.06 HorsePower$

We will use the common size 10*HorsePower* motor

The volume of oil required to manually move the forming head at 1 inch/sec is as follows:

To manually extend the head:

$1 gallon = 231 inches^3$

$CPAE * 1 inch = 8.3 inches^3$

$8.3 inches^3 / 231 inches^3 = .036 gallons / second$

$(.036 gallons / second) * (60 seconds / 1) = 2.16 gallons / minute$

Using a 4-gallons/minute pump, the velocity that can be achieved manually extending the head 1inch/second:

$4 gallons / minute / 2.16 gallons / minute = 1.85 inches / second$

To manually retract the head:

$1 gallon = 231 inches^3$

$CPAR * 1 inch = 5.16 inches^3$

$5.16 inches^3 / 231 inches^3 = .023 gallons / second$

$(.023 gallons / second) * (60 seconds / 1) = 1.34 gallons / minute$

Using a 4 gallons/minute pump, the velocity that can be achieved manually retracting the head 1inch/second:

$4 gpm / 1.34 gpm = 2.98 inches / second$

Motion Controller Information Calculations:

The setup information for the motion controller to make its calculations requires the following input data.

Resolution to be used for calculations = .00025 inch

Axis Data:
Output Type = D/A
Input Type = Encoder
Output Slot Channel = 1.1
Input Slot Channel = 1.1
Encoder Driver = Differential
Encoder Type = Quadrature

Scaling Data Requires:

Input Scaling:

Feedback Units = 4 (4*resolution to = .001” of an inch = 4*.00025 = .001 inch)
Ladder Units = 1 (1LU = .001 inch so values in the ladder to = 1 inch are * 1000)
So 4 inches in the ladder = 4000
Ladder Units/Axis Units = 1 (These are the units of measurement for the system and must be integers, at 1 no further scaling is needed)

Output Scaling:

Commanded Voltage = 10000 mv (This is equal to 10V which is the analog signal the Controller outputs)
Motor RPM at Voltage = 23.6 inches/second or 1416 inches/minute (This is our calculated *Vf*)
Counts/Motor Rev = 4000 pulses/inch (Based on the resolution, 4000*.00025 = 1 inch)

Iterator Data:

Velocity Limit = $Vf * (Counts / Mtr\,Rev) * (AU / LU) * (LU / FU)$
$1416 * 4000 * 1 * (1/4) = 1{,}416{,}000 AU / minute$

Acceleration Ramp = $VelocityLimit / t =$
$1416000 / .175 = 8{,}091{,}428 AU / minute / second$

Deceleration Ramp = $VelocityLimit / t =$
$1416000 / .175 = 8{,}091{,}428 AU / minute / second$

Controlled Stop Ramp = $VelocityLimit / t * 10^{1} =$
$1416000 / .175 = 80{,}914{,}280 AU / minute / second$

Move Accel/Decel Max Accel = $(3/2) * VelocityLimit / 3 seconds =$
$(3/2) * 1416000 / 3 = 708000 AU / min/ sec$

Move Accel/Decel Constant Jerk = 3* Max Accel/3 = 708000 AU/min/sec/sec

Based on previous projects the following are givens:

Slow and Fast Velocity Filters = 0ms
Slow/Fast Velocity Threshold = 0 AU/minute
Rollover Position = 0 AU
Software Upper Limit = +100000
Software Lower Limit = -100000
Ignore Limits = Yes
Resume able Estop Allowed? = No

Position Data:

Input Polarity = Negative
Output Polarity = Negative
Analog Output Offset = 0mv
Feed Forward % = 0%
Proportional Gain (Kp) = 2000 (AU/min)/(AUFE)
Integral Gain (Ki) = 0 (AU/min)/(AUFE*min)
Derivative Gain (Kd) = 0 (AU/min)/(AUFE/min)

+ Integral Error Limit = +100
- Integral Error Limit = -100
Following Error Limit = $(Counts / Motor\,\mathrm{Re}v)/8*(AU/LU)*(LU/FU)$

$4000*8*.250 = 125AU$

This will be fine tuned on start up

Update rate for the axis = 1.0 ms

In Position Band = 10LU*(AU/LU) = 10 AU This will be fine tuned on start up

Note:

The servo file setup data is used to determine the movement of the proportional valve during operation. We do not enter values for voltage for moving the valve during different modes of operation. The motion controller uses the values entered above plus for certain moves we provide a position and a rate to the motion controller and it adjust the valve accordingly through its analog output to the valve.