D90/D180 Options and Updates

Senior Design Proposal submitted to the
Department of Mechanical and Materials Engineering
College of Engineering and Applied Science
University of Cincinnati

in partial fulfillment of the requirements for the degree of

Bachelor of Science

in Mechanical Engineering Technology

by

Michael Hall

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Thesis Advisor: Amir Salehpour

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Problem Statement

Valco Melton currently offers a tank unit called the D180, capable of holding 180kg of adhesive within the tank. Dan Davidson and Edwin Quinones have asked that the unit be redesigned to accept the mounting and use of two MVV 40cc/rev pumps to offer high output flow to our customers. Currently the highest output offered is 12.93cc/rev.

Research

Valco Melton is an adhesive application system manufacturer located in Cincinnati, Ohio. At Valco, we engineer and manufacture application systems that dispense adhesive onto various different products in many applications, a few of these applications being, corrugated boxes, nonwovens, such as diapers and feminine products, and many other fields. Valco Melton offers many solutions to packaging needs as well as the RV and automotive industries. We offer many units ranging from applicator and melter units made right here in the United States.

In conjunction with the applicator and melter units currently offered at Valco Melton, tank units are a good mediator between the two. Tank units are used to store melted adhesive before being pumped to the applicator head. The current offerings through Valco Melton are our signature D48, D90, and D180 hot melt units. One of the largest issues we currently face with our larger tank units is the lack of high flow rate pumps and pressure monitoring functionality. Our units are currently limited to 12.36cc/rev pumps and we are currently capable of mounting two of these. One large issue that currently plagues these units is the level of difficulty in replacing pumps or manifolds. The manifolds that these pumps attach to

are extremely heavy and awkward to hold, especially when the unit is fully assembled and the parts need changed on the field.

As previously mentioned, the current solution is inadequate as it doesn't allow us to cater to customers requiring higher flow rates. MVV pumps offer an incredibly high flow rate for cheap and putting two of these pumps together will allow Valco to bridge that gap and go even further using two high flow rate pumps. Currently our solution for running one and two Viking pumps is inadequate because it is costly, overly large, and leaves a lot of dead space within the manifold, thus increasing the cost and machining time. These MVV pumps will allow us to run upwards of 40cc/rev per pump while simultaneously decreasing the overall dimensions of the manifold the pump mounts to.

Applicable Standards

For this proposed project, no applicable standards are to be held as this unit is entirely done and "standardized" within Valco Melton. Some internal standards that are to be held is the tolerance standards we have on our machined parts as well as our HiPot test standards used on heaters and other parts that are typically tested electronically. Valco Melton also applies various safety standards within our manufacturing and production aspects to prevent and limit our pinch points, burn risks, as well as crush hazards on our tank units and our other similar units.

State of the Art

As the D48/D90/D180 units already exist, these existing units will be used as state of the art as we currently offer these units. Our competitors, Graco, Nordson, and Robatech units will also be referenced as they exist within the same category of intermediary tank units. Within this field, Valco Melton currently offers the highest holding capacity within the competition with the 180kg holding capacity of the D180 hot melt unit.

As of today, solutions that currently exist to provide customers with higher flow rate applications are limited to approximately 25cc/rev when using dual 12.36cc/rev pumps on D180 and similar units within this field. These pumps are perfectly adequate for customers running higher viscosity adhesives as once the viscosity reaches a certain point, the flow rate is limited and these 12cc/rev and lower pumps do a great job at maximizing the available pump rate. Where these smaller pumps lack is when customers are using lower viscosity fluids, where the flow rate is really limited on the pump itself as the adhesive flows really well.

End User

The end user of these hot melt tank units are customers that require adhesive application onto their products. Some of the largest applications for hot melt adhesive are: the corrugated box packaging manufacturers, commercial vehicle and RV lamination, as well as nonwoven applications such as diapers and various other feminine products on the market today. These industries apply across the board from a majority of Valco Melton units as well as our competitors in the hot melt adhesive application field.

Summary of Research

In conclusion, though Valco Melton and our competitors have various solutions towards offering increased flow rate options on our tank units, but 12cc/rev is one of the highest pump options offered within our market. Of course, the dual pump option exists and thus doubles flow rate, but with this design project, offering 40cc/rev pumps, for both single and dual options, will further increase the flow rate Valco Melton is capable of offering to our customers who require that higher flow rate for both higher and lower viscosity adhesives. Valco Melton will be offering a solution to a problem that currently plagues our market as high flow rate units are expensive simply due to being “one offs” and requiring multiple hours of engineering time to create and finish. These “one off” units are considered projects due to not being a standard option offered on our units or any of our competitor’s units.

Quality Function Deployment

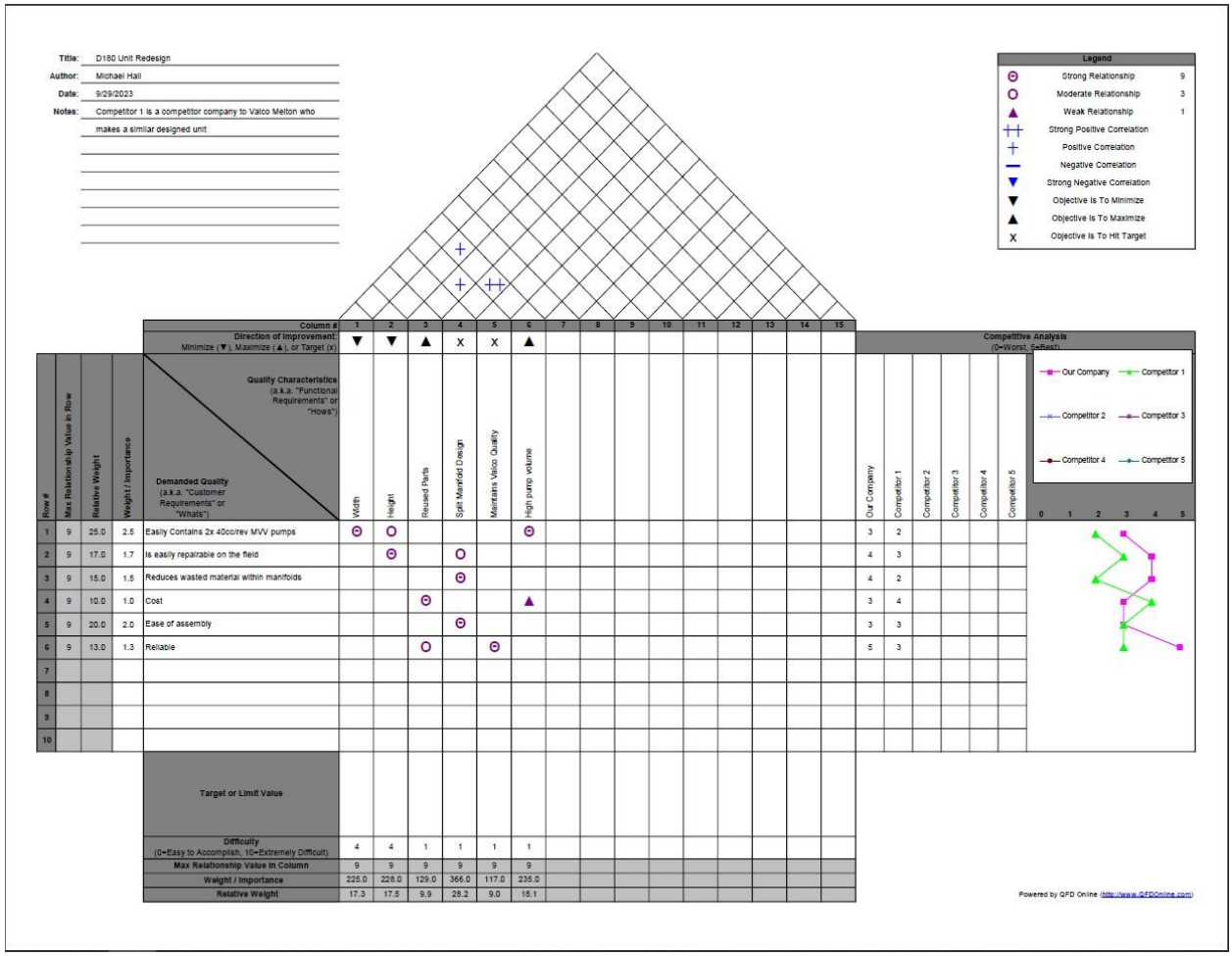
Customer Features

- Ability to mount and run upwards of two 40cc/rev MVV pumps
- Continue offering a unit that is easy to maintain on the field
- Reliable
- Cheap to purchase/maintain

Engineering Characteristics

- Redesigned collector tank with 2 equal flow outlets
- Maintain the current height/width of the current unit
- Reuse as many current parts as possible
- Two equal flow manifolds for dual pump units ○ One MVV design and one Viking Design
- Bring manifold machining back to in house to cut cost
- Updated HMI with fewer electrical components inside the cabinet

House of Quality / Interview with Sponsor



Product Objectives:

- Width – 17.3%
- Height – 17.5%
- Reused Parts – 9.9%
- Split Manifold Design – 28.2%
- Maintains Valco Quality – 9.0%
- High Pump Volume – 18.1%

Team Members and Responsibilities:

Michael Hall – Responsible for the redesign of the D180 tank unit in order to accomplish the goal of housing 2 40cc/rev MVV pumps.

Concepts Drawings

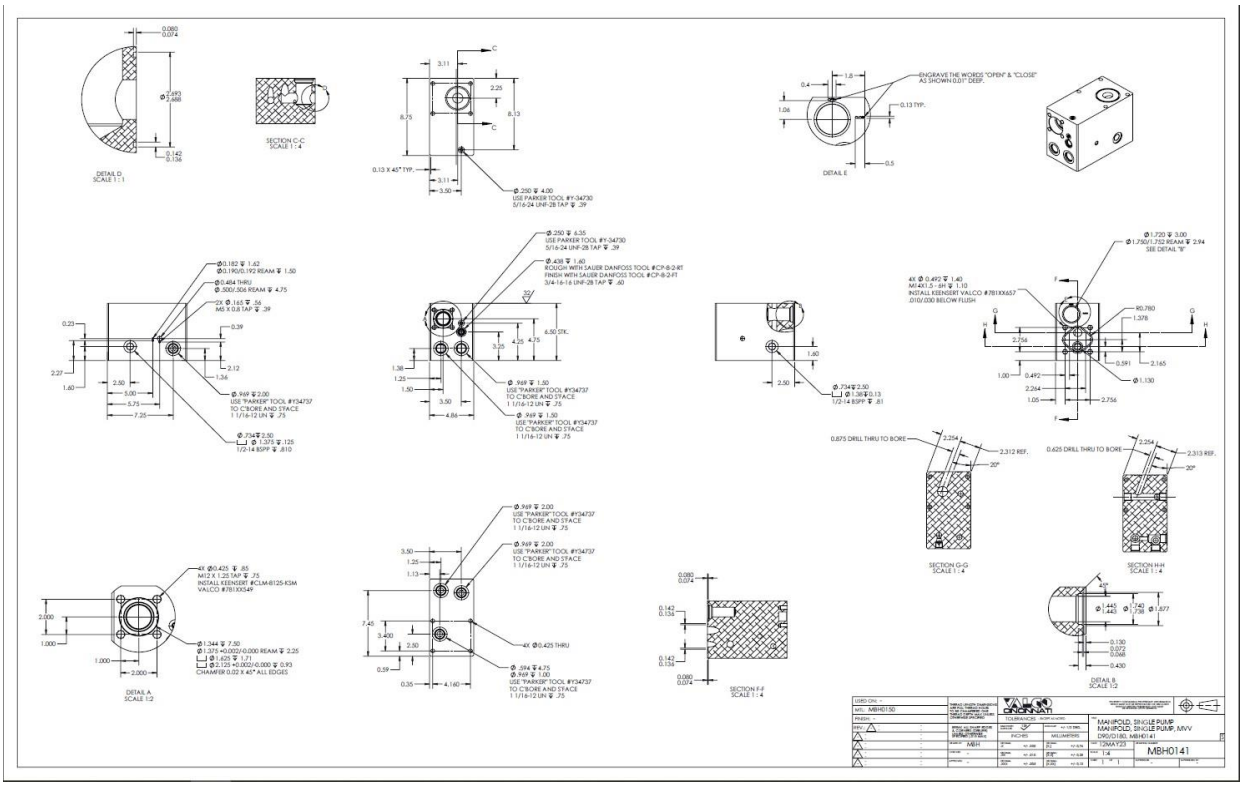


Figure 1 MVV Manifold Design

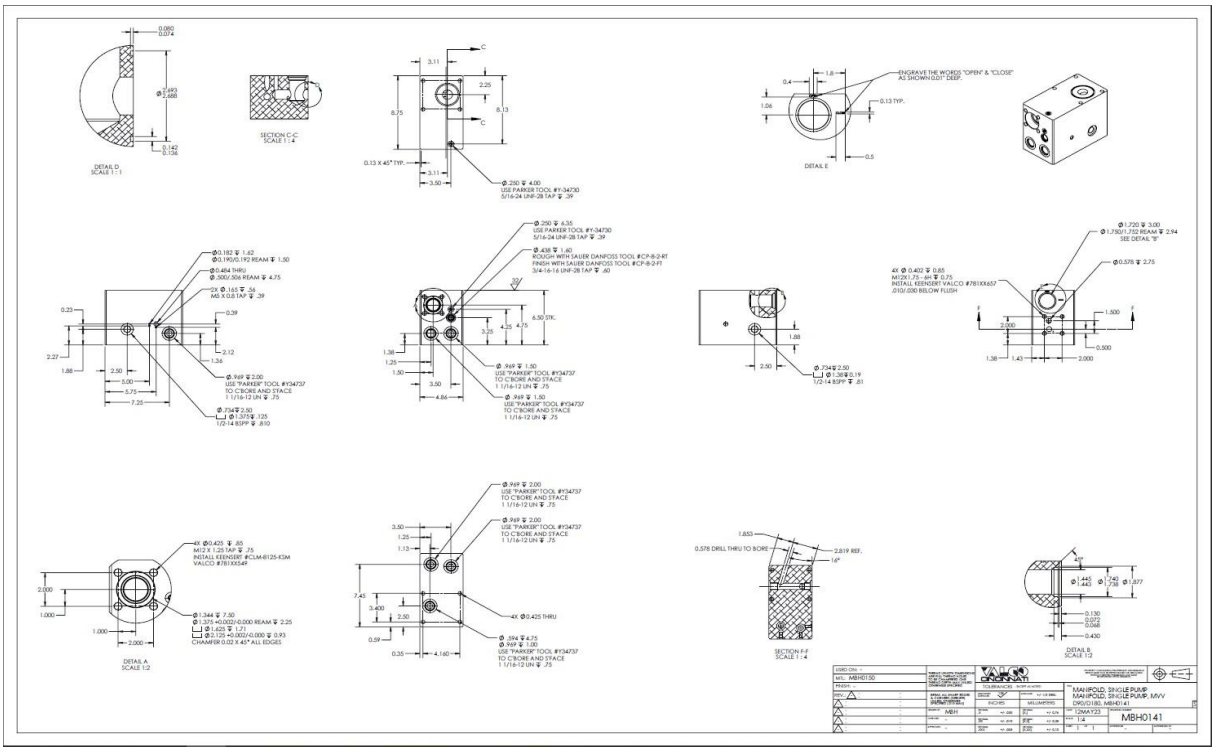


Figure 2 Viking Manifold Design

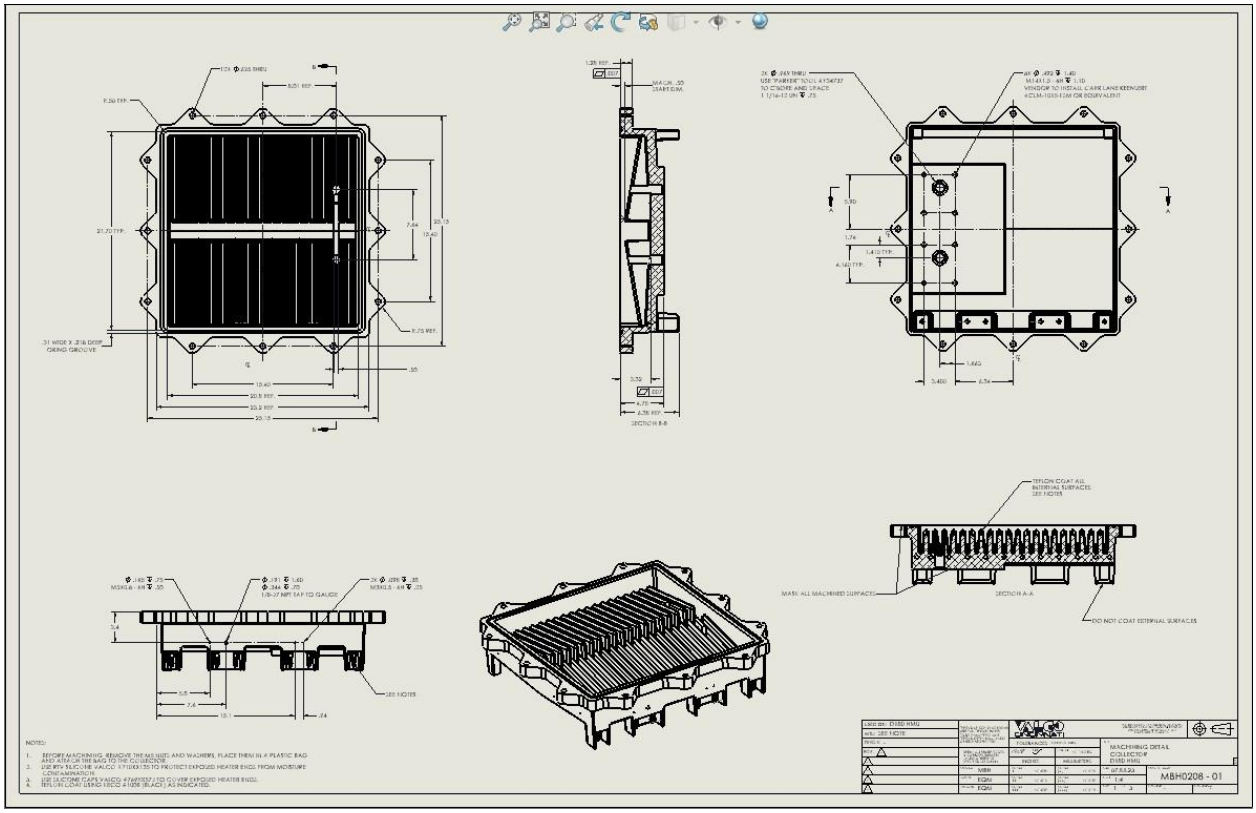


Figure 3 Dual Exit Equal Flow Collector Design

Three initial concepts have been designed in order to solve the problem we currently face. Two different manifold designs have been created in order to mount both MVV and Viking pumps to our current D180 unit. These two manifolds are identical with the only difference being the pump mounting face, one accommodating MVV pumps and the other Viking pumps. The collector has also be redesigned from the ground up in order to split the melted adhesive into two equal outlets, one outlet per pump.

Fabrication and Assembly

Fabrication Processes

For the designed parts in this project, a large majority of the newly designed parts will be made outside of Valco's machine shop due to being sheet metal parts or large cast and machined parts that we aren't capable of doing. The most important part of this project, the new manifold designs, will be made in-house within Valco's machine shop. The collector will be purchased/fabricated through Durex Industries, the sheet metal parts will be made through Hartzell Manufacturing.

Due to a large influx of customer orders, all manufacturing orders for engineering prototypes have been pushed to the back of the machine shop scheduling. This is also true for purchasing requisitions we have sent out to all our vendors. We have asked all our vendors to push prototype orders back and prioritize standard part number orders in order for us to push out customer orders quicker. All of this has put a damper on this project and has overall stopped assembly and physical testing for this project.

Assembly Methods

For the assembly methods, no assembly has taken place as of yet for this project due to the explained back up of customer orders within the machine shop. Due to a large number of

customer orders within the machine shop, production has also been extremely busy with putting together new customer units.

When production for this new D180 begins, this will be a collaboration between production and myself to get this unit built correctly and tested in the proper manner.

Testing and Proof of Design

Testing Methods

As far as testing methods go, no physical testing has been completed due to the previously mentioned concerns within the machine shop and the production floor. In the future when this unit is assembled and ready to be tested, this unit will go through Valco's rigorous testing methods as if this unit was going to be sent to a customer. This unit will also go through other testing in order to confirm maximum flow out of a single 40cc/rev MVV pump as well as dual 40cc/rev pumps.

Up to this point, hand calculations, using our in-house calculators, have been done in order to properly determine the increases as well as the benefits of adding 40cc/rev pumps to this unit. A comparison has been made to see the major differences between a 12.72cc/rev pump versus the newly added 40cc/rev pumps. Pressure drop calculations have also been done to confirm that added these pumps as well as changing these manifolds will still allow us to gravity feed these pumps from the collector.

Results

Based upon the hand calculations and calculators we have and use at Valco, the "theoretical" results for a 40cc/rev pump versus the older 12.72cc/rev pumps are as follows:

- Single 12.72cc/rev – 167.9 lbs per hour
- Dual 12.72cc/rev – 335.8 lbs per hour
- Single 40cc/rev – 528 lbs per hour
- Dual 40cc/rev – 1056 lbs per hour

When comparing the new manifold to the old one, the pressure drop from manifold inlet to pump inlet is cut in half. The old manifold had a pressure drop of 12psi which is extremely high. If the pressure drop is at or above atmospheric pressure, then the adhesive will not be able to properly feed the pumps. For the new manifold, the total pressure drop from manifold inlet to pump inlet is 6psi which is much better than the older design. This will promote better flow to the pump.

Project Management

Project Budget Limit

No specific project budget has been assigned to this project as this is something that has never been done before.

Key Milestones

Milestone	Due Date	Actual Dates
Research	**9/01/23**	**9/01/23**
Background Report	**9/01/23**	**9/01/23**
QFD	**9/29/23**	**9/29/23**
HOQ	**9/29/23**	**9/29/23**
Concept Drawings	**10/10/23**	**10/10/23**

3D model	**11/01/23**	**11/01/23**
Manufacturing Orders	**11/10/23**	**5/10/24**
Assembly	**12/01/23**	**6/01/24**
Revisions to Design	**12/08/23**	**7/01/24**

Plans to Finish

As far as plans to finish, within the coming month or two, the manifolds and all purchased parts will be fabricated in house and sourced outside in order to get this unit fully assembled and tested in house. After complete testing has been completed, the unit will then go into our engineering testing area to be used for customer tests as well as salesmen showings in order to get this unit turned into a standard product and eventually sold to our customers.

Conclusion:

In conclusion, everything for this project has been completed besides physical testing and assembly in house. This will all be completed within the coming months in order to get this unit listed as a standard unit within Valco Melton's catalog. From here, we will be able to offer these options straight to our customers for purchase.

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5. **InvisiPac HM50 Hot Melt Adhesive Dispense System. *Graco.* [Online] [Cited: October 10, 2023.] https://www.graco.com/us/en/in-plant-manufacturing/product-group/invisipac-hm50-hot-meltadhesive-dispense-system.html.**

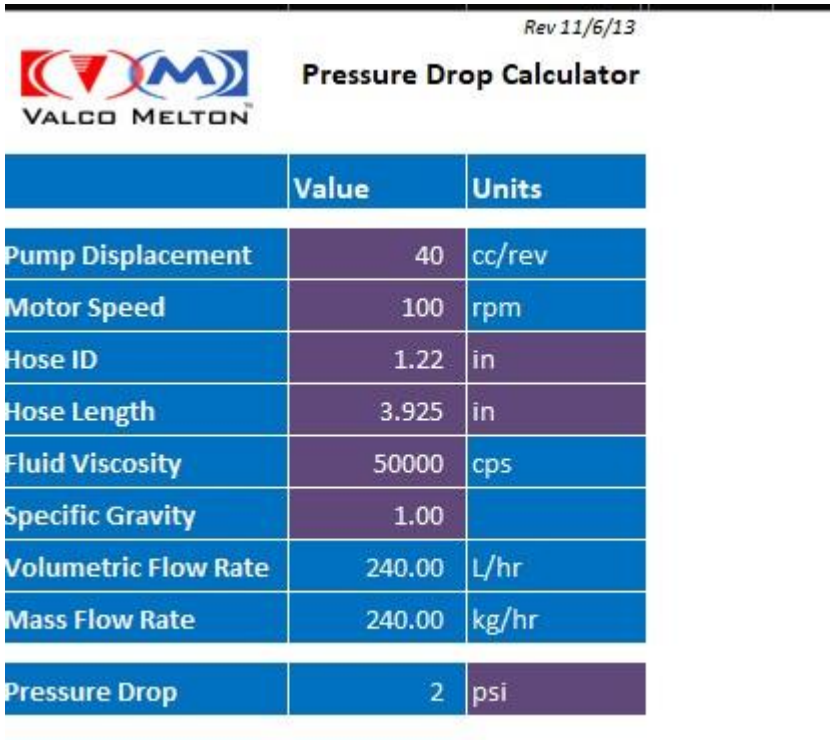
Appendices

Displacement (in/rev)	0.388
Motor Speed (rpm)	170
Adhesive Pressure (psi)	655
Motor Power (Hp)	0.333333
Motor Torque (in*lb)	108
Power Required (Hp)	0.109101
Torque Required (in*lb)	40.44677
Power Safety Factor	3.055287
Torque Safety Factor	2.670176

Motor MFG	Motor Type	Hp	RPM	Pump	Power	Torque	Power SF	Torque SF
Bison	Fixed	1/4	159	Standard	0.085	33.96	2.92	2.68
		1/4	159	Double	0.171	67.93	1.45	1.34
	Variable @60Hz	1/4	161	Standard	0.088	33.96	2.88	2.36
		1/4	161	Double	0.174	67.93	1.44	1.18
Bodine	Fixed	1/3	170	Standard	0.092	33.96	3.64	3.18
		1/3	170	Double	0.183	67.93	1.82	1.59
	Variable @60Hz	3/8	150	Standard	0.081	33.96	4.64	3.62
		3/8	150	Double	0.161	67.93	2.32	1.81

Motor				Adhesive Pressure	
MFG	Type	Hp	RPM	Power Based	Torque Based
Bodine	Fixed	1/3	170	685	653
		3/8	170	771	743
	Variable @60Hz	3/8	150	886	957

Figure 4 Motor Calculations Calculator



Rev 11/6/13

VALCO MELTON

Pressure Drop Calculator

	Value	Units
Pump Displacement	40	cc/rev
Motor Speed	100	rpm
Hose ID	1.22	in
Hose Length	3.925	in
Fluid Viscosity	50000	cps
Specific Gravity	1.00	
Volumetric Flow Rate	240.00	L/hr
Mass Flow Rate	240.00	kg/hr
Pressure Drop	2	psi

Figure 5 Pressure Drop Calculator