Bisnet

" Solutions for Tomorrow, Today! "

"The Die Casting Process Planner"

Users Manual

August 5, 2002

A Product By:

Bisnet

DCPP
Users Manual

Table of Contents

Chapter 1
PQ^2

What is PQ Squared?

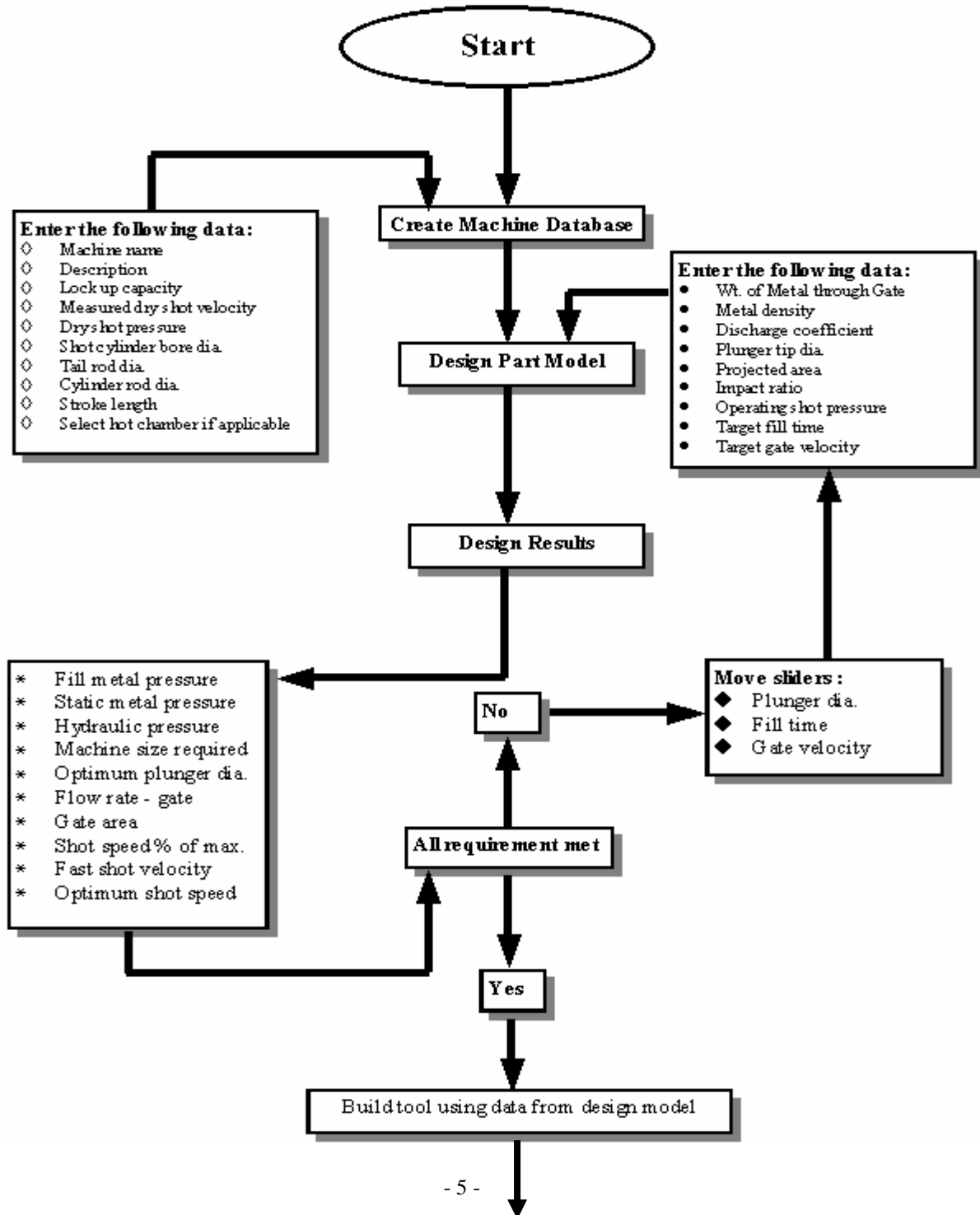PQ^2 is a mathematical formulation that describes the relationship between pressure and flow rate of a liquid in a confined space. When used in the die casting process, it defines the relationship between liquid metal pressure and metal flow rate through the in-gate.

Graphically, the PQ^2 relationship compares the metal pressure (P), represented on the vertical axis, with the metal flow rate (Q), represented on the horizontal axis. The horizontal axis is skewed to illustrate the squared relationship of flow rate with pressure.

This program will assist you in defining the capability of your die casting machine and the required process to achieve the desired product quality requirements. The program will calculate the critical process characteristics that you must maintain to achieve the desired results. As you know, die casting is a complex, highly interactive process. DCPP simplifies much of this complexity to allow you to efficiently design the best process for your needs. In addition to careful monitoring of other important die casting variables, such as cycle rate, die temperature, and air venting, utilizing the PQ^2 concepts in DCPP is the ultimate means of attaining a sound die casting process design.

Chapter 2
Software Flowchart

Die Cast Process Planner
Flow Chart

Start

Create Machine Database

Enter the following data:
◊ Machine name
◊ Description
◊ Lock up capacity
◊ Measured dry shot velocity
◊ Dry shot pressure
◊ Shot cylinder bore dia.
◊ Tail rod dia.
◊ Cylinder rod dia.
◊ Stroke length
◊ Select hot chamber if applicable

Design Part Model

Enter the following data:
• Wt. of Metal through Gate
• Metal density
• Discharge coefficient
• Plunger tip dia.
• Projected area
• Impact ratio
• Operating shot pressure
• Target fill time
• Target gate velocity

Design Results

* Fill metal pressure
* Static metal pressure
* Hydraulic pressure
* Machine size required
* Optimum plunger dia.
* Flow rate - gate
* Gate area
* Shot speed % of max.
* Fast shot velocity
* Optimum shot speed

No

Move sliders:
◆ Plunger dia.
◆ Fill time
◆ Gate velocity

All requirement met

Yes

Build tool using data from design model

Die Cast Process Planner
Flow Chart (Continued)

Set tool
⇒ **Set machine parameters using data from design model & velocity profile**

Run Die

Measure Actual Results:
◊ Wt. metal through gate
◊ Operating shot pressure
◊ Actual fast shot velocity
◊ Actual gate area
◊ Actual hyd. head pressure
◊ Actual hyd. rod pressure

Make necessary adjustments in accordance to the actual model

Actual Model

Enter Data Into Actual Model

Actual Results

* Fill metal pressure
* Static metal pressure
* Machine size required
* Discharge Coefficient
* Flow rate - gate
* Shot speed - % max.
* Fill time
* Gate velocity

Move sliders :
◆ Plunger dia.
◆ Gate area
◆ Fast shot velocity

No

Design Requirements Met?

Yes

Design Complete

Chapter 3
Getting Started

Getting Started
Die Cast Process Planer
(DCPP)
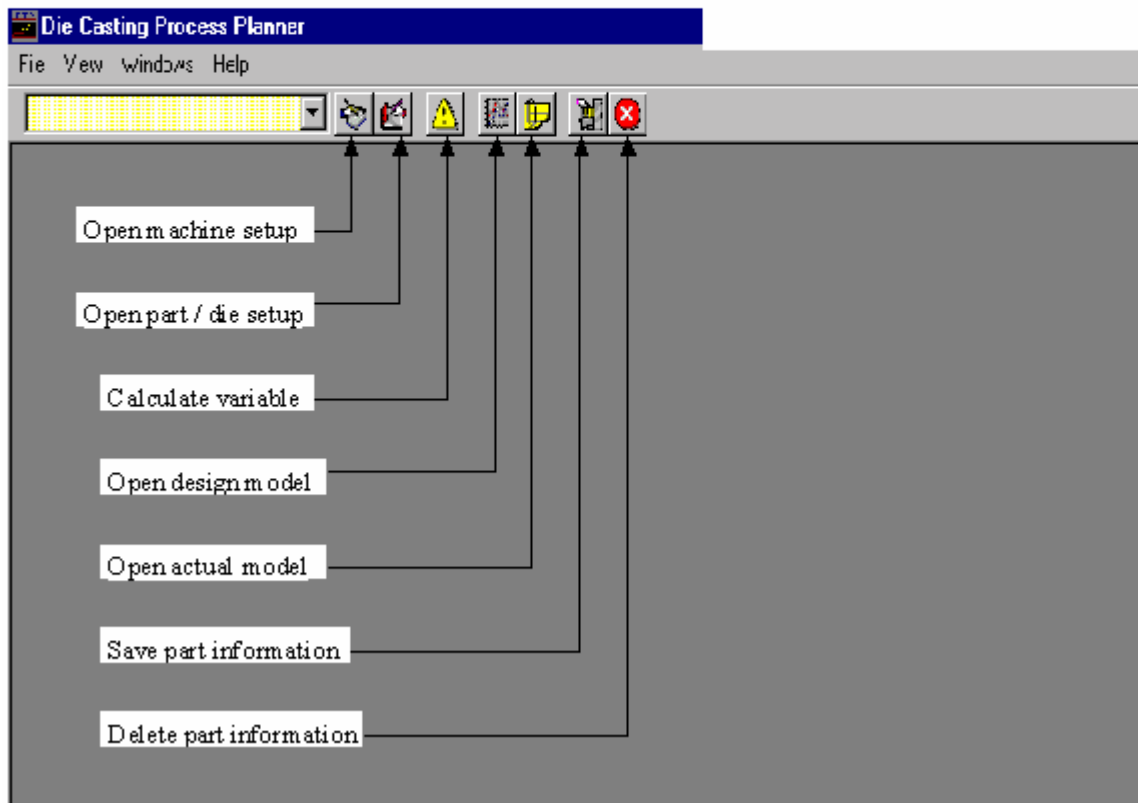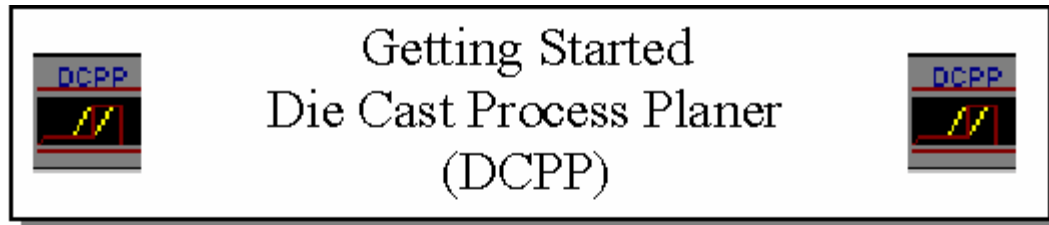
Above is the Main Menu that you will see as you enter the DCPP program for the first time. The function of each of the icons is described in the illustration above. Once you have used DCPP, the software will open to the last screen you were using just before closing the last time you had used it. For example, if you are working on an important job and closed the software at the end of the afternoon with that job's information displayed, when you open the software the next morning, your job will be displayed as you left it the previous day.

Chapter 4
Machine Capability

The following list of variables are required to define machine capability and are used to calculate the machine capability line in the software:

- **Machine Lock Up Capacity**
- **Machine Dry Shot Velocity**
- **Machine Hydraulic Pressure During Dry Shot**
- **Shot Cylinder Bore Diameter**
- **Tail Rod Diameter**
- **Cylinder Rod Diameter**
- **Cylinder Stroke Length**
- **Hot Chamber / Cold Chamber**

## Gathering Machine Capability Data

Cold Chamber

1. Place either rags or gloves in the shot sleeve from within the die.
   (Warning: make sure that the sleeve is not hot enough to ignite the cloth).
2. Charge the shot bottle to the pressure that is most typically used by your machine. This is your **Hydraulic Pressure** during **Dry Shot**.
3. Complete one shot with the fast shot bottle completely open and the intensifier off.
4. With your shot monitoring system, measure the maximum sustained shot speed that the machine is capable of achieving. Complete this test for at least three shots to prove repeatability. This is your **Dry Shot Velocity**.

Hot Chamber

1. With the shot cylinder fully returned, measure the clearance between the top of the gooseneck and the bottom of the shot cylinder shaft.

2. Find or make a cushion block to absorb the shock during testing. This block should stop the cylinder one to two inches before it bottoms out. This block should be made from steel or wood.
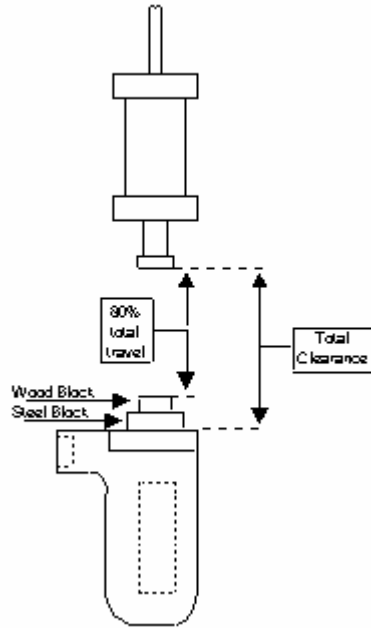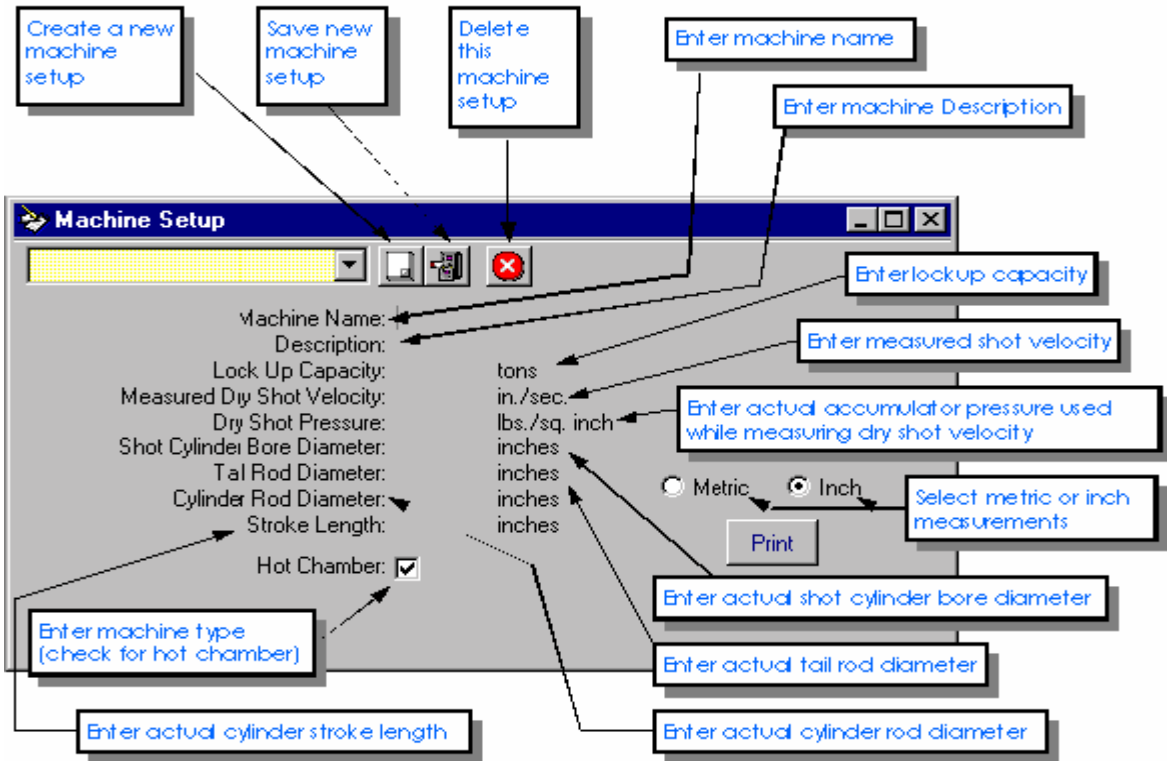

Example: the machine you are testing has a total
clearance of 12 inches, and the cylinder shaft length
is 10 inches. Therefore, you will need a block that is
to 4 inches thick.

3. Charge the shot bottle to the pressure that is most typically used by your machine. This is your **Hydraulic Pressure** during **Dry Shot**.
4. Cycle the machine with the fast shot bottle completely open.
5. With your shot monitoring system, measure the maximum sustained plunger velocity for at least three shots to prove repeatability. This is your **Dry Shot Speed** that the machine is capable of achieving.

Complete this study on all of your machines. If possible, print out a velocity and pressure profile for each capability study that you complete and keep them on file. Repeat capability studies every six to twelve months, searching for performance trends. Update the machine database as machine capability changes.
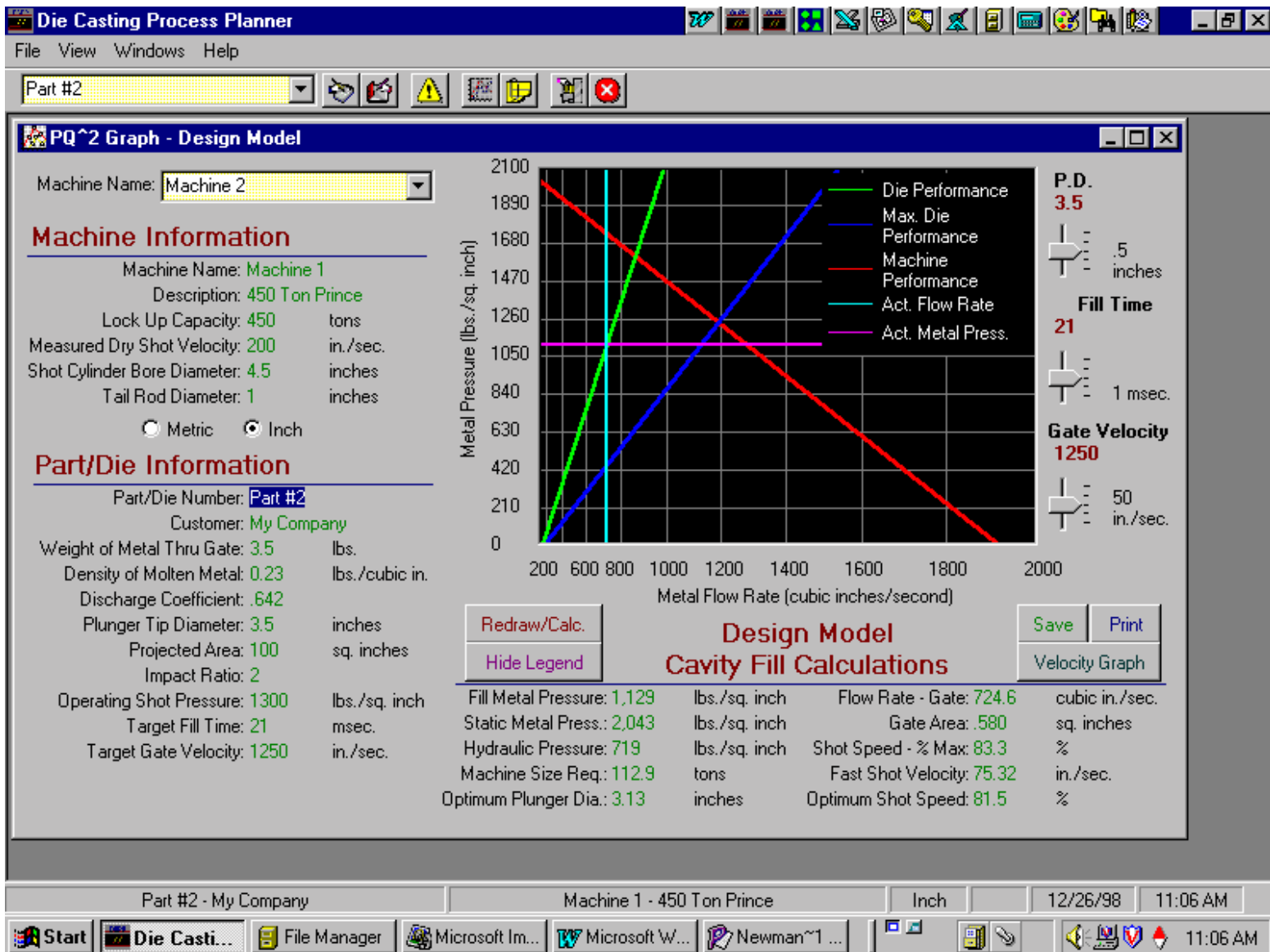
Machine Setup

Create a new machine setup

Save new machine setup

Delete this machine setup

Enter machine name

Enter machine Description

Machine Setup

Enter lockup capacity

Enter measured shot velocity

Enter actual accumulator pressure used while measuring dry shot velocity

Select metric or inch measurements

Enter actual shot cylinder bore diameter

Enter actual tail rod diameter

Enter actual cylinder rod diameter

Enter machine type (check for hot chamber)

Enter actual cylinder stroke length

Machine Name:
Description:
Lock Up Capacity: tons
Measured Dry Shot Velocity: in./sec.
Dry Shot Pressure: lbs./sq. inch
Shot Cylinder Bore Diameter: inches
Tail Rod Diameter: inches
Cylinder Rod Diameter: inches
Stroke Length: inches

Hot Chamber: ☑

○ Metric   ⊙ Inch

Print

Chapter 5
Machine Database

Follow the above illustration (Machine Setup screen - Chapter 4) to enter and save new machine capability information into the machine database. The machine database will maintain capability information on all the machines within your plant.

Chapter 6
Design Model

Die Casting Process Planner

File   View   Windows   Help

Part #2

PQ^2 Graph - Design Model

Machine Name: Machine 2

Machine Information

Machine Name: Machine 1
Description: 450 Ton Prince
Lock Up Capacity: 450   tons
Measured Dry Shot Velocity: 200   in./sec.
Shot Cylinder Bore Diameter: 4.5   inches
Tail Rod Diameter: 1   inches

○ Metric   ● Inch

Part/Die Information

Part/Die Number: Part #2
Customer: My Company
Weight of Metal Thru Gate: 3.5   lbs.
Density of Molten Metal: 0.23   lbs./cubic in.
Discharge Coefficient: .642
Plunger Tip Diameter: 3.5   inches
Projected Area: 100   sq. inches
Impact Ratio: 2
Operating Shot Pressure: 1300   lbs./sq. inch
Target Fill Time: 21   msec.
Target Gate Velocity: 1250   in./sec.

Graph legend:
- Die Performance (green)
- Max. Die Performance (blue)
- Machine Performance (red)
- Act. Flow Rate (cyan)
- Act. Metal Press. (magenta)

Metal Pressure (lbs./sq. inch) — vertical axis: 0, 210, 420, 630, 840, 1050, 1260, 1470, 1680, 1890, 2100

Metal Flow Rate (cubic inches/second) — horizontal axis: 200, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000

P.D.
3.5
.5 inches

Fill Time
21
1 msec.

Gate Velocity
1250
50 in./sec.

Redraw/Calc.
Hide Legend

Design Model
Cavity Fill Calculations

Fill Metal Pressure: 1,129	lbs./sq. inch	Flow Rate - Gate: 724.6	cubic in./sec.	
Static Metal Press.: 2,043	lbs./sq. inch	Gate Area: .580	sq. inches	
Hydraulic Pressure: 719	lbs./sq. inch	Shot Speed - % Max: 83.3	%	
Machine Size Req.: 112.9	tons	Fast Shot Velocity: 75.32	in./sec.	
Optimum Plunger Dia.: 3.13	inches	Optimum Shot Speed: 81.5	%	

Save   Print
Velocity Graph

Part #2 - My Company   Machine 1 - 450 Ton Prince   Inch   12/26/98   11:06 AM

Start | Die Casti... | File Manager | Microsoft Im... | Microsoft W... | Newman~1 ...   11:06 AM

1. Enter all information required in **Part/Die Information** section. The following definitions may assist in this process:

   Weight of Metal Thru Gate: The total weight of all metal that passes through the gate during the shot. This includes the part, overflows, vacuum system, and flash.

   Density of Molten Metal: The liquid density of the molten metal alloy used. When using English measurements, the units are pounds per cubic inch. When using Metric measurements, the units are grams per cubic centimeter.

   Discharge Coefficient: The kinetic friction from all shot end components from the shot cylinder to the shot sleeve combined with the fluid friction of the molten metal going through the gating system.

   Plunger Tip Diameter: The diameter of the shot plunger tip and shot sleeve.

   Projected Area: The area of the entire shot projected against the ejector die. This includes total area of the part, overflows, vacuum system, and flash.

   Impact Ratio: The ratio of the true impact pressure to the cavity fill metal pressure used to determine an estimate of the machine tonnage required.

   Operating Shot Pressure: The accumulator pressure used for the given part.

   Target Fill Time: The desired fill time for a given part.

   Target Gate Velocity: The desired gate velocity for a given part.

2. Choose the machine to be used by selecting the pull down window by machine name and then selecting the proper machine.

3. Select the **Redraw/Calculate** button.

4. Evaluate the **Cavity Fill Calculations** based upon the machine capability and process requirements to assure that the process design is acceptable.

Specifically, make sure that a) the shot speed percentage of maximum is less than 80 to 90 percent of the machine's capability; b) the machine size required does not exceed the size of the machine to be used; and c) the selected plunger diameter is reasonably close to the optimum plunger diameter.

5. Make adjustments to the Design Model using the sliders on the right hand side of the graph.

6. Evaluate the required velocity profile by pressing the **Velocity Graph** button.

DCPP   DCPP

Redraw/Calc.	**Design Model**		Save	Print
Hide Legend	**Cavity Fill Calculations**		Velocity Graph	

Fill Metal Pressure: 571	lbs./sq. inch	Flow Rate - Gate: 393.4	cubic in./sec.	
Static Metal Press.: 2.781	lbs./sq. inch	Gate Area: .442	sq. inches	
Hydraulic Pressure: 267	lbs./sq. inch	Shot Speed - % Max: 53.2	%	
Machine Size Req.: 57.1	tons	Fast Shot Velocity: 55.65	in./sec.	
Optimum Plunger Dia.: 2.86	inches	Optimum Shot Speed: 53.0	%	

◆	Fill metal pressure:	PRESSURE DURING CAVITY FILL PHASE
◆	Static metal pressure:	MAXIMUM METAL PRESSURE CAPABILITY OF THE MACHINE
◆	Hydraulic pressure:	MINIMUM HYDRAULIC HEAD PRESSURE REQUIRED FOR CAVITY FILL
◆	Machine size required:	MACHINE TONNAGE REQUIRED TO WITHSTAND PROJECTED PRESSURE
◆	Optimum plunger diameter:	OPTIMIZES MACHINE CAPABILITY TO ACHIEVE FILL REQUIREMENTS
◆	Flow rate through gate:	VOLUME FLOW RATE OF METAL THROUGH GATE
◆	Gate area:	AVERAGE GATE THICKNESS TIMES THE GATE LENGTH
◆	Shot speed, % of maximum:	PERCENTAGE OF MAXIMUM SHOT SPEED AVAILABLE
◆	Fast shot velocity:	PLUNGER SPEED TO ATTAIN CAVITY FILL REQUIREMENTS
◆	Optimum shot speed:	SHOT SPEED % OF MAXIMUM USING OPTIMUM PLUNGER DIAMETER

◆	Redraw / recalc.	REDRAW THE PQ^2 GRAPH AND RECALCULATE THE FILL CONDITIONS
◆	Hide legend:	HIDES THE LEGEND ON THE PQ^2 GRAPH
◆	Save:	SAVES YOUR DESIGN, MACHINE AND PART / DIE COMBINATION
◆	Print:	PRINTS DESIGN
◆	Velocity graph:	THEORETICAL VELOCITY PROFILE FOR THE PLUNGER / CYLINDER MOVEMENT

Use sliders to dynamically change design

P.D.
3

.25 inches

Fill Time
21

1 msec.

Gate Velocity
889

50 in./sec.

Metal Pressure (lbs./sq. inch)

	Die Performance
	Max. Die Performance
	Machine Performance
	Act. Flow Rate
	Act. Metal Press.

2800
2520
2240
1960
1680
1400
1120
840
560
280
0

150 450 600 750 900 1050 1200 1350 1500

Metal Flow Rate (cubic inches/second)
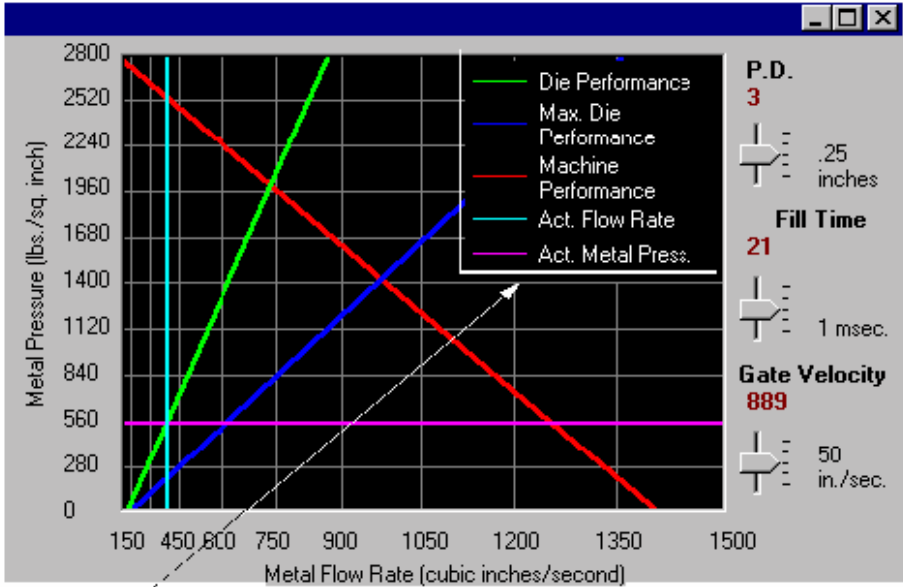
Push redraw / calculate button to redraw the PQ^2 graph and cavity fill calculations

Redraw/Calc.

Hide Legend

**Design Model
Cavity Fill Calculations**

Save   Print

Velocity Graph

Fill Metal Pressure: 571	lbs./sq. inch	Flow Rate - Gate: 393.4	cubic in./sec.
Static Metal Press.: 2.781	lbs./sq. inch	Gate Area: .442	sq. inches
Hydraulic Pressure: 267	lbs./sq. inch	Shot Speed - % Max: 53.2	%
Machine Size Req.: 57.1	tons	Fast Shot Velocity: 55.65	in./sec.
Optimum Plunger Dia.: 2.86	inches	Optimum Shot Speed: 53.0	%

See next page

Machine Performance Line

This line is the red diagonal line that is defined by the maximum metal pressure on its upper left point and by the dry shot flow rate on its lower right point. If the required metal pressure and required flow rate lines intersect below and to the left of this line, then the machine will be capable of achieving the cavity fill requirements. If the intersection is above and to the right of this line, then the machine is not capable of achieving the fill requirements.

Die Performance Line

This line is the green diagonal line that begins at zero metal pressure and zero metal flow rate and extends up to the right. The angle that this line projects from the zero point is determined by the discharge coefficient of friction from the die and machine combination. The smaller the discharge coefficient, the more the die performance line angles upward. The greater the discharge coefficient, the more the die performance line angles to the right.

Maximum Die Performance Line

This is the blue line to the right of the die performance line. This line represents what the die performance line would look like if the discharge coefficient were one. Therefore, this line indicates a theoretical "best case scenario" for the pressure and flow relationship of a given die and machine combination.

Actual Metal Flow Rate Line

This light blue, vertical line illustrates the calculated metal flow rate determined in the cavity fill calculations.

Actual Metal Pressure Line

This magenta, horizontal line represents the calculated metal pressure determined in the cavity fill calculations. The intersection point of this line and the Actual Metal Flow Rate Line indicates the point where the machine is operating in the PQ Squared diagram.

<u>How to Edit Cavity Fill Requirements</u>

Sliders

Using the sliders on the left side of the screen, you may interactively change plunger diameter, fill time, and gate velocity. Use the sliders as follows:

    Plunger Diameter Slider

    1. Sliding up to increase the diameter will:
        a. decrease the metal pressure required to fill your part.
        b. decrease the static metal pressure capability of your machine.
        c. reduce the machine tonnage requirement.
    2. Sliding down to decrease the diameter will:
        a. increase the metal pressure required to fill your part.
        b. increase the static metal pressure capability of your machine.
        c. increase the machine tonnage requirement.

    Fill Time Slider

    1. Sliding up to increase the fill time will:
        a. decrease the gate area required.
        b. decrease shot speed percentage of maximum required.
        c. decrease fast shot velocity required to fill your part.
    2. Sliding down to decrease the fill time will:
        a. Increase gate area required.
        b. Increase shot speed percentage of maximum required.
        c. Increase fast shot velocity required to fill your part.

    Gate Velocity Slider

    1. Sliding up to increase the gate velocity will:
        a. decrease gate area required.
        b. increase shot speed percentage of maximum required.
        c. increase the metal pressure required to fill your part.

    2. Sliding down to decrease the gate velocity will:
        a. increase gate area required.
        b. decrease shot speed percentage of maximum required.
        c. decrease the metal pressure required to fill your part.

After your design meets your requirements, remember to save your work by selecting the **Save** button.

Chapter 7
Velocity Graph

Velocity Graph

Velocity Profile - Design Model

Machine Name:

Machine Information

Machine Name: Machine 1
Description: 450 Ton Prince
Lock Up Capacity: 450 Tons
Shot Speed (% of Max): 89.65773 %
Cylinder Stroke Length: 10 inches

○ Hot Chamber   ○ Cold Chamber

Part/Die Information

Part/Die Number: Part #1
Customer: My Company
Weight of Metal Thru Gate: 1.9 lbs.
Total Shot Weight: 5 lbs.
Plunger Tip Diameter: 3.25 inches
Distance to Cover Pour Hole: 1 inches
Nozzle Diameter: 1 inches
Nozzle + Button Length: 12 inches
Gooseneck Diameter: 1.5 inches
Gooseneck to Metal Level: 10 inches
Slow Shot Velocity: 25 in./sec.

Legend:
— Close Pour Hole
— Start Fast Shot
— Metal at Gate
— Die Full
— Velocity Profile

Velocity (inches/second) vs. Position (inches)

[Redraw/Calc.] [Hide Legend]

Miscellaneous Calculations

Volume of Metal Thru Gate: 6.26
Volume of Runners & Sprue: 13.48
Fast Shot Velocity: 82.98
Time Available for Vacuum: .1307

Metal at Button Position: 2.13
Metal at Sprue Position: 3.27
Metal at Gate Position: 4.89
Impact Position: 5.89

[Print]

◆ Setup your machine to mirror this profile and the fill conditions will be attained
◆ The data from this graph can be used to communicate with the controller on your shot sys-

1. Enter all additional information required under **Part/Die Information**. The following definitions may assist in this process:

   Total Shot Weight:
   The total weight of all metal that enters the die during each shot. This includes all metal that goes through the gate, the runner system, and the biscuit or sprue.

   Distance to Cover Pour Hole:
   The distance required to advance the plunger past the metal fill hole in both hot chamber and cold chamber.

   Hot Chamber Variable Definitions:

   Nozzle Diameter: The inside diameter of the nozzle used.

   Nozzle + Button Length: The length of the nozzle plus the length of the button.

   Gooseneck Diameter: The inside diameter of the gooseneck used.

   Gooseneck to Metal Level: The length from the face of the gooseneck to the furnace metal level.

   Slow Shot Velocity: The slow shot velocity to be used for the given part.

Velocity Graph
(Hot Chamber Requirements)
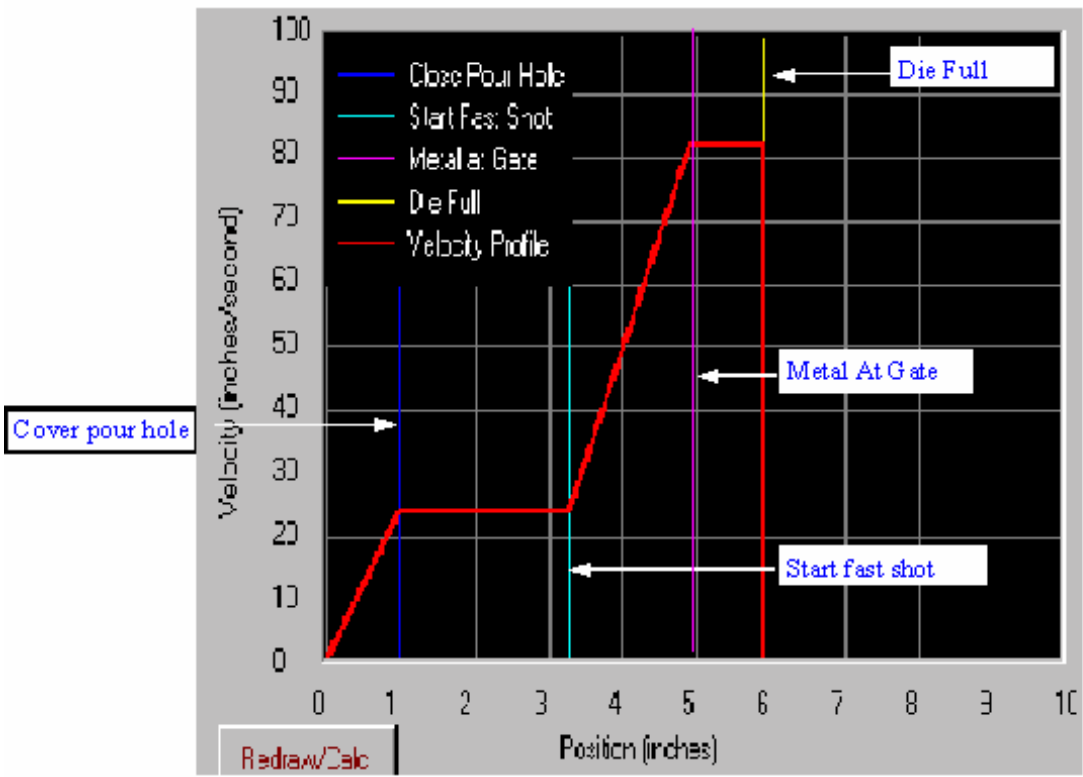
DCPP

DCPP

Close Pour Hole
Start Fast Shot
Metal at Gate
Die Full
Velocity Profile

Die Full

Metal At Gate

Cover pour hole

Start fast shot

Velocity (inches/second)

Position (inches)

Redraw/Calc

Machine Information

Machine Name: Machine 1
Description: 450 Ton Prince
Lock Up Capacity: 450 tons
Shot Speed (% of Max): 89.65778 %
Cylinder Stroke Length: 10 inches

⦿ Hot Chamber   ◯ Cold Chamber

Part/Die Information

Part/Die Number: Part #1
Customer: My Company
Weight of Metal Thru Gate: 1.9 lbs.
Total Shot Weight: 5 lbs.
Plunger Tip Diameter: 3.25 inches
Distance to Cover Pour Hole: 1 inches
Nozzle Diameter: 1 inches
Nozzle + Button Length: 12 inches
Gooseneck Diameter: 1.5 inches
Gooseneck to Metal Level: 10 inches
Slow Shot Velocity: 25 in./sec.

New part /die setup requirements
◆ Total shot weight
◆ Distance to cover pour hole
◆ Nozzle diameter (I.D.)
◆ Nozzle + button length
◆ Gooseneck (exit) diameter
◆ Gooseneck to metal level
◆ Slow shot velocity

Cold Chamber Variable Definitions:

Pour Hole Velocity: The plunger velocity required to pass the pour hole to avoid splashing metal out of the sleeve.

Biscuit Thickness: The average thickness of the biscuit.

Effective Sleeve Length: The distance from the face of the tip to the end of the sleeve.

Intensifier Ratio: If a multiplication hydraulic circuit is used, this ratio is the pressure multiplication in the intensification circuit of your machine. If an intensifier bottle is used, this is the ratio of the intensifier bottle pressure to the shot bottle pressure.

Velocity Graph
Cold chamber Requirements
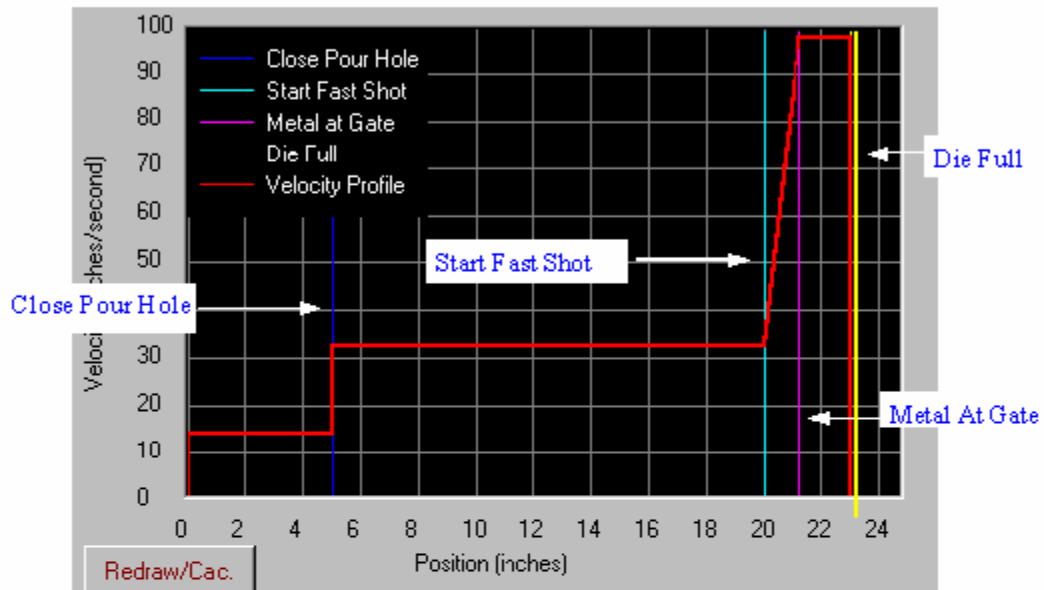
Machine Information

Machine Name: Machine 2
Description: 450 Ton Prince
Lock Up Capacity: 449.7354 tons
Shot Speed (% of Max): 76.98834 %
Cylinder Stroke Length: 0.708661 inches

○ Hot Chamber   ● Cold Chamber

Part/Die Information

Part/Die Number: Part #1 - Cold Chamber
Customer: My Company
Weight of Metal Thru Gate: 5 lbs.
Total Shot Weight: 8.5 lbs.
Plunger Tip Diameter: 3 inches
Distance to Cover Pour Hole: 5 inches
Pour Hole Velocity: 15 inches
Biscuit Thickness: 2 inches
Effective Sleeve Length: 25 inches
Intensifier Ratio: 1.5

New part /die setup requirements
◆ Total shot weight
◆ Distance to cover pour hole
◆ Pour hole velocity
◆ Biscuit thickness
◆ Effective Sleeve length
◆ Intensifier ratio

2. Select the **Redraw/Calculate** button.

3. Evaluate the Velocity Graph and calculations to assure that the process data entered are accurate.

4. Miscellaneous Calculations Descriptions

    Hot Chamber Variables:

    Volume of Metal Thru the Gate: The weight of the metal through the gate divided by the metal density. This value is used in the calculation of fill distance.

    Volume of Runners and Sprue: The result of the total shot weight minus the weight of the metal through the gate divided by the metal density. This value is used to calculate the distance between the Metal at Gate position and the Metal at Sprue position.

    Fast Shot Velocity: The plunger velocity during cavity fill. The calculation for fast shot velocity considers the plunger diameter, the required fill time, and the weight of the metal through the gate.

    Time Available for Vacuum: The amount of time from the start of the shot to the Metal at Sprue Position.

    Metal at Button Position: The calculated plunger position when the metal front gets to the button.

    Metal at Sprue Position: The calculated plunger position when the metal front gets to the end of the nozzle.

    Metal Gate Position: The calculated plunger position when the metal front gets to the in-gate of the die cavity.

    Impact Position: The calculated plunger position when the cavity is entirely full.

Velocity Graph
Hot Chamber Calculations

DCPP

DCPP

Redraw/Calc.

Hide Legend

Position (inches)

Miscellaneous Calculations

Print

Volume of Metal Thru Gate: 8.26
Volume of Runners & Sprue: 13.48
Fast Shot Velocity: 82.98
Time Available for Vacuum: .1307

Metal at Button Position: 2.13
Metal at Sprue Position: 3.27
Metal at Gate Position: 4.89
Impact Position: 5.89

Make sure you use the correct plunger velocity & vacuum as called out on the design

Note the out puts, compare your the data to the data from an actual shot profile

Cold Chamber Variables:

Volume of Metal Thru the Gate: The weight of the metal through the gate divided by the metal density. This value is used in the calculation of cavity fill distance.

Volume of Runners & Biscuit: The result of the total shot weight minus the weight of the metal through the gate divided by the metal density. This value is used to calculate the distance between the Metal at Gate position and the Sleeve Full position.

Shot Sleeve Full Percentage: The total shot weight divided by the effective volume of the sleeve multiplied by 100. The effective volume of the sleeve is calculated from the die side of the pour hole to the end of the sleeve.

Critical Slow Shot Velocity: The slow shot velocity required to minimize air entrapment within the metal that enters the die cavity. This is calculated based upon Garber's Fluid Flow Model within a die casting sleeve.

Fast Shot Velocity: The plunger velocity during cavity fill. The calculation for fast shot velocity considers the plunger diameter, the required fill time, and the weight of the metal through the gate.

Intensified Metal Pressure: The metal pressure during the intensification phase of the shot. It is calculated by multiplying the static metal pressure by the intensifier ratio.

Sleeve Full Position: The calculated plunger position when the metal front gets to the base of the runner.

Metal Gate Position: The calculated plunger position when the metal front gets to the in-gate of the die cavity.

Impact Position: The calculated plunger position when the cavity is entirely full.

Time Available for Vacuum: The amount of time from the Distance to Cover the Pour Hole to the Metal at Sprue Position.

Velocity Graph
Cold Chamber Calculations

Position (inches)

Redraw/Calc.

Hide Legend **Miscellaneous Calculations** Print

Volume of Metal Thru Gate: 12.50	Intensified Metal Pressure: 2,102
Volume of Runners & Biscuit: 8.75	Sleeve full Position: 19.99
Shot Sleeve Full Percent: 12.0	Metal at Gate Position: 21.23
Critical Slow Shot Velocity: 33.55	Impact Position: 23.00
Fast Shot Velocity: 98.24	Time Available for Vacuum: .4468

Make sure you use the correct plunger velocity
& vacuum as called out on the design

Note the out puts, compare your the data to the data from an
actual shot profile

Chapter 8
Sample Tool

1. Set up the tool using the data from the design model and velocity graph calculations. Assure that the following are set properly:
   a) Tool is in the chosen machine.
   b) Chosen gooseneck or sleeve and plunger are set in the machine.
   c) Accumulator pressure and pre-charge are correct.
   d) Shot speed setting is correct.

2. Preheat tool to desired temperature.

3. Install monitoring equipment.
   a) Position transducer
   b) Pressure transducer (head side)
   c) Pressure transducer (rod side)

4. Collect data using monitoring equipment while focusing on the averages during cavity fill and the overall shot profile. Collect data on the following:
   a) Average fast shot velocity during cavity fill
   b) Average hydraulic head pressure during cavity fill
   c) Average hydraulic rod pressure during cavity fill
   d) Weight of all metal passing through the gate
   e) Total shot weight
   f) Slow shot velocity
   g) Pour hole velocity (if cold chamber)

5. Manually measure the in-gate area and the actual projected area.

6. Enter the above data into the **Actual Model**.

Chapter 9
Actual Model

Using the Actual Model

1. Verify that the proper machine appears in the **Actual Model** machine used.

2. Enter the following **Part/Die Information**:
   a) Actual operating pressure
   b) Actual fast shot plunger velocity
   c) Actual measured gate area
   d) Actual hydraulic head pressure measured during cavity fill
   e) Actual hydraulic rod pressure measured during cavity fill
   f) Verify all other part/die and machine information to be correct

Part/Die Information

Part/Die Number:	Part #2	
Customer:	My Company	
Weight of Metal Thru Gate:	3.500	lbs.
Density of Molten Metal:	.230	lbs./cubic in.
Plunger Tip Diameter:	3.500	inches
Projected Area:	100.000	sq. inches
Impact Ratio:	2	
Operating Shot Pressure:	1500	lbs./sq. inch
Actual Fast Shot Velocity:	56	in./sec.
Actual Gate Area:	.3	sq. inches
Actual Hyd. Head Press.:	1350	lbs./sq. inch
Actual Hyd. Rod Press.:	25	lbs./sq. inch

Redraw/Calc.	Actual Model	Save	Print
Hide Legend	Cavity Fill Calculations	Velocity Graph	

Fill Metal Pressure: 2,082	lbs./sq. inch	Flow Rate - Gate: 538.8	cubic in./sec.
Static Metal Press.: 2,357	lbs./sq. inch	Shot Speed - % Max: 98.1	%
Machine Size Req.: 208.2	tons	Fill Time: 28.24	msec
Discharge Coeff.: .679		Gate Velocity: 1795.94	in./sec.

3. Review the **Actual Model Cavity Fill Calculations**.

a) Compare results to the design model.
b) If the results match your design intent and the quality results of your sample were acceptable, then you have successfully used DCPP to design your process.
c) If the results do not match or if the quality results were not acceptable, then make adjustments as follows:
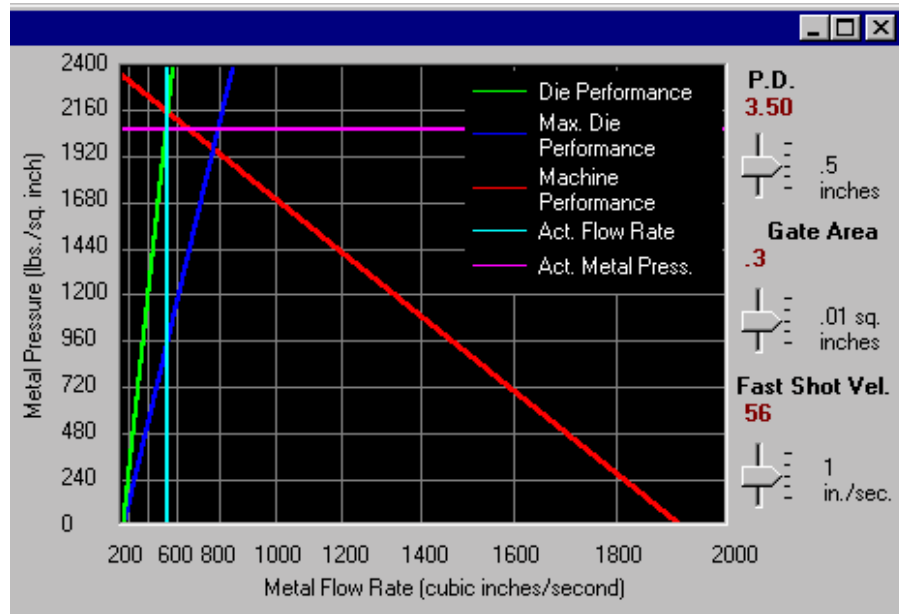
i) If your parts have mis-runs or poor fill, use DCPP to consider one or more of the following strategies:

- Reduce fill time by increasing your fast shot velocity. (Note: increasing fast shot velocity will also increase gate velocity. Therefore you may also need to increase the gate area to avoid excessive gate velocity.)
- Increase metal temperature to increase heat into the die.
- Increase die temperature in the problem area by reducing internal or external cooling or by adding hot oil.

ii) If your parts have excessive internal shrinkage porosity, use DCPP to consider one or more of the following strategies:

- Increase gate velocity by reducing gate area or by increasing fast shot velocity. (Note: increasing fast shot velocity will also reduce fill time.)
- Increase metal pressure by reducing plunger tip diameter. (Note: you should verify and adjust for the effect of reduced plunger diameter.)
- Reduce metal temperature to reduce required intensification.

- Increase intensification pressure.
- Reduce the intensification rise time from impact to peak intensification pressure.

iii) If your parts have excessive gas porosity, use DCPP to verify that the actual slow shot velocity is the same as the critical slow shot velocity. You may also try the following strategies:
- Test slow shot velocities slightly greater than and less than the critical slow shot velocity (+/- 1 to 2 inches per second).
- Reduce plunger tip lubricant (cold chamber).
- Reduce die spray in the problem area.
- Increase die temperature in the problem area.

Using Discharge Coefficient

DCPP is unique because it allows for mathematical calculation of discharge coefficient from actual process data. The discharge coefficient of kinetic friction is affected by the cavity geometry, runner geometry, plunger tip size, tip to sleeve drag, shot end hydraulic fluid drag, hydraulic piston drag, and leakage from head side to rod side within cylinder. The actual discharge coefficient is a valuable gauge of shot end performance over time and for evaluation of an individual die's gating system. Using SPC charting, someone in your company should track discharge coefficient by machine and by die so that problems can be detected and resolved with hydraulic cylinders, shot sleeves, and plunger tips. In addition, discharge coefficient should be tracked so that the representation of discharge coefficient in the design model can become more accurate for each of your machines over time.

Chapter 10
DCPP Databases

There are two databases that are maintained by DCPP. These are the **Machine Database** and **Part Database**. The Machine Database only includes machine capability data. However, the Part Database includes the **Part/Die Information** and the **Machine Information**. This is because the discharge coefficient, which is very important in process evaluation, is a function of the machine and the die. Therefore, each job must be saved with all the machines in which it will run.

You may view either of these two databases by pressing the **Machine and Part Database** icons at the top of the main menu.