

ADVANCED TECHNOLOGIES WORLDWIDE, INC.

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THE HOPSCOTCH MIXER

Over the years, screw design has been a critical issue for the plastics industry. Like a perpetual "mousetrap", screw manufacturers and designers are always attempting to create a higher output screw that will provide an excellent melt as well.

An overview of the more common mixers available includes many of the following: the original "pin" mixing screw, this consists of various rows of equally spaced mixing pins, single or alternated that could be placed as interrupted or non-interrupted to the metering flights. Soon after, the Maddock mixing section (Union Carbide) was introduced, this is a fluted or grooved mixer with undercuts or dams milled to a smaller outside diameter than the actual screw outer diameter. The Egan, Dulmage and Pineapple mixers were also designed utilizing the same principle and idea as the Maddock mixer.

Recently, a new generation of mixing screws have been offered utilizing the "Barrier" principle and wave designs such as those patented by Barr, Willard, HPM, etc. For color dispersion solutions, several mixers have been very successful: this includes the twisted Maddock, Z mixers, Dray mixer and the Pulsar. Many will also increase overall melt and output of the mixing screw. Unfortunately, as an unwanted side effect, many of these mixers produce shear and retention of the process resin, thus eliminating their use in a variety of applications.

ATW has seen the majority of the process problems experienced in the industry. One such existing problem is the increased troubleshooting requirements due to enhanced sophistication of materials and resins. *ATW* is familiar with the considerable change in processing requirements with clients who primarily use regrind or require continuous color changes. Clients attempting to use one screw for multiple resins may find the screw is extremely efficient in one process, while the performance is poor in the remaining processes. The shear factor may also cause material degradation and premature wear at the mixer or barrier ends.

To solve these and many other processing problems, *ATW* designed a new type of mixing screw - *The Hopscotch*. In order to develop a more universal, multi-advantageous design, *ATW* has taken into consideration the successes of some of the present mixers available (i.e., such as pins, Barriers and Maddock mixing sections).

The Hopscotch Mixer consists of various grooves in the metering section of the screw with alternated interruptions capable of orienting the material flow, which in turn eliminates shear. The flow in groove one is the same as the second and third: this allows the same volume of material to pass through. Also, as the grooves are located at equal distances from one another, proper melt and mix is assured. Each groove provides consistent pressure relief. As a result, control and stabilization of accumulating head pressure is secure.

Sequence of the grooves may also be modified depending on the actual process. The overall screw design will include the required compression ratio, feed, transition, and metering sections to work the material and provide a proper melt.

One of the many advantages of *The Hopscotch Mixer* is the ease of use for required color changes. Material is much easier to purge since there are no dead ends where resin can be trapped and retained. On the same principle, processors utilizing contaminated regrind material will no longer experience the typical problems caused by metal particles. Maddock and Barrier screws often encounter these problems. Critical problems such as barrel and screw seize ups, that normally required considerable down time for cleaning and repairs, will virtually be eliminated.

Due to the superior mixing and melt of *The Hopscotch Mixer*, the ability to deepen the metering section exists; this allows an increase in overall output rates. Lbs/hours screw RPM rate will increase considerably in extrusion processes, as quality remains consistent. In injection processes, *The Hopscotch Mixer* will notably shorten traditional recovery times.

The Hopscotch Mixing Screw can be designed to process the following materials:
ABS*POLYSTYRENE*PVC*VINYL*NYLON*PET*LDPE*HDPE*LLDPE*POLYPROPYLENE*

IS YOUR MACHINE ON THE ROCKS?

Pretend for a moment your molding machine is a canoe. The hydraulic/electric system is the river, the injection unit is the rear paddler, and the clamping unit is the front paddler. What is the paddle? It would have to be the screw. The screw provides the push to steer the part in the right direction. It controls how much plastics goes into the mold, how it is mixed, how viscous it is, and how much stress is molded into the part. The screw is the little paddle that controls the show.

Thus, it is quite fitting that we evaluate screws by molding canoe paddles. Anyone who has been canoeing knows that the paddles are always brightly colored and thin. Few have probably stopped to think about the color mixing problems this can pose. Custom molder Mayfair Plastics of Gaylord, Michigan has. This world-class molder of automotive and recreational parts molds mountains of these paddles and knows all about the mixing headaches that can be created. We came into contact with Mayfair and partnered with them to test mixing screws in their new 400 ton molding machine molding a polypropylene canoe paddle. Mayfair was particularly interested in a screw that could mix polypropylene without creating streaking. Meanwhile, we were able to add a series of our own tests to provide a comprehensive overview of

a polypropylene/mixing screw's performance.

Seven different screws were evaluated in this test. We'll provide a quick run through of the participants and then provide you with details on each manufacturer's screw before going on to the test results. The participants are: Advanced Technologies Worldwide, Glycon Corp., Servtek Inc. (A division of Milacron Inc.), New Castle Industries Inc., Spirex Corp., Westland Corp., and Xalby Inc. All of these companies provide parts (specifically injection unit components), for the injection molding industry.

Information Regarding Each Screw In This Evaluation

All screws have a basic goal- to provide the highest possible output while providing an excellent melt. Each manufacturer attempts to solve this puzzle in different ways. This section will detail each manufacturer's design and their reasoning behind these designs.

Advanced Technologies Worldwide- ATW has designed a new type of mixing screw titled The Hopscotch Mixer. The Hopscotch design is intended to provide the overall melt quality and output of the popular "Barrier" principle screws while reducing the shear and retention of the process resin. ATW contends that this can be a problem with many of the "Barrier" style screws currently available on the market. Their design consists of various grooves in the metering section of the screw with alternated interruptions capable of orienting the material flow, which in turn eliminates shear. The flow in groove one, is the

SCREWS



▲ XALOY



▲ SPIREX



▲ NEW
CASTLE



▲ MILACRON



▲ GLYCON



▲ ADVANCED
TECHNOLOGIES



▲ WESTLAND

same as the flow in the second and third; this allows the same volume of material to pass through. The grooves are located at equal distances from one another intentionally to assure proper melt and mix. Each groove provides consistent pressure relief. As a result, control and stabilization of accumulating head pressure is secure.

Glycon Corp.- In our opinion, Glycon has the most unique design of any of the screws in this evaluation. The screw design is a Barr-E.T. with a new, unique mixing device on the end of the screw called the "Infuser". In the E.T. section of the screw, the melt is allowed to pass over the secondary flight along with unmelted material. The undercuts on the secondary flights are quite large compared to the barrier clearance in a barrier screw. This geometry creates random distributive and dispersive mixing of the melt and solid, creating heat transfer. The "Infuser", added to the end of the E.T. section, consists of a series of fixed and floating rings to thoroughly mix and homogenize the melt. The fixed rings (Rotors) are attached to the screw and rotate at the same velocity as the screw. The floating rings (Stators) are positioned between the Rotors and rotate at a much lower velocity than the screw. Material is only allowed to transfer through the mixer when there is a momentary alignment of the axial holes. This axial transfer of material from Rotor to Stator produces a high degree of distributive mixing.

Milacron Inc.- The MELTSTAR screw with Spiral Mixer is another variation on the common barrier screw design. The undercut barrier flight separates solids from the melt. The melt channel cross section is continually increasing in the down channel direction to minimize shear and work input to the melted particles that flow over the barrier flight. The solid channel cross section is continually decreasing in the down channel direction to maintain compression and work input to the unmelted particles. By removing the melted material from the working compression channel, unmelted pellets are continually presented to the barrel surface, maximizing the melting capacity of the screw. The barrier's melting capacity is combined with a spiral mixing head to provide melt homogeneity and color mixing. The multiple spiral channels split the material flow in the vertical plane, and the V-cuts in the outer diameter split the material flow in the horizontal plane. This screw is also available without the spiral mixer for higher output & less stringent mixing applications.

New Castle Industries- The Stratablend mixing screw is designed as a general purpose mixing screw. It achieves this mixing by a continuous series of short grooves and lands in the root, which allow for both extensional and shear mixing as well as a high level of distributive mixing. The grooves in the root are cut into a conventional flighted section with a very shallow depth. In order for the polymer to flow forward, it passes from groove to groove over a series of shallow lands, thereby receiving a series of high and low intensity shear. The length and degree of shear

can be varied to suit the requirement by varying the number and geometry of the grooves and lands quite independent of the output rate. The design tested was a conventional "non-barrier" screw with a mixing section at the discharge end.

Xaloy Corp.- Xaloy's approach in this test was to develop a root geometry that would meet the desired rate required with excellent color mixing. The root geometry is a design utilizing two types of mixing devices. The rate requirements created a deep meter depth. Staggered mixing pins located in the first few flights of the meter zone were used creating a cross-channeling

ALL SCREWS HAVE A BASIC GOAL~ TO PROVIDE THE HIGHEST POSSIBLE OUT~ PUT WHILE PROVIDING AN EXCELLENT MELT.

Spirex Corp.- The MeltPro Barrier Screw by Spirex is a variation on the barrier screw design. The feed section conveys in the same

way as a conventional screw. At the beginning of the transition zone, a second flight is started. This flight is called the barrier, or intermediate, flight and it is undercut below the primary flight OD. The barrier flight separates the solids channel from the melt channel. The barrier flight moves under the melt film and the melt is collected in the melt channel. In this manner, the solid pellets and melted polymer are separated and different functions are performed on each. The melt channel is deep to provide low shear. The solids channel becomes shallower, forcing the unmelted pellets against the barrel for efficient frictional melting. The solids bed continues to get shallower and finally disappears into the back side of the primary flight. Spirex's Z-Mixer was also installed at the end of the screw. The Z-Mixer assists in melting and mixing by re-orientating the material into at least three separate channels. There are also variable flight depth clearances that take place, adding to the shearing ability and, hence, melting capability. This combination of multiple re-orientation, coupled with barrier flights, is designed to produce a low standard deviation in melt quality via the combination of melting and mixing.

Westland Corp.- The Eagle screw by Westland has a mixing section which utilizes wiping lands with large helix angles to rapidly convey the melt either over alternating barrier lands or through mixing notches in the barrier lands. A reduced root diameter in the mixer, as compared with the preceding meter section, allows the mixer to accept substantially all (over 95%) of the melt volume available to it without creating a pressure drop of causing excessive shear. This design is intended to allow the Eagle screw to be run at high speeds (250 RPM or more) without degrading or overheating.

effect. The intent is to deliver a more homogenized melt to the mixer located at the end of the meter zone. The final mixer is a X-201 mixer that allows both distributive and dispersive mixing. The feed zone is 48% of the screw while the metering zone is 32% of the screw. The longer metering zone was used for the rate required, and the quality issues good color mixing posed.

Test Results

Mayfair's Mixing Problem. Mayfair was using a standard, general purpose screw manufactured by the molding machine manufacturer. With this screw they saw a mixing problem with green colorant when running a normal cycle. Therefore, they had to increase the cycle time to fix this problem. The first test we ran was to see if we could reduce the cycle time back down to normal levels with the new screws installed. The colorant level was kept at 4%. All seven screws were able to fix Mayfair's problem and reduce the cycle time down to normal levels.

Note: The mixing tests were run with Mayfair's heat profiles. It could be expected that all screws would perform even better with profiled heats set specifically to fit the screw design.

Mixing. This test was conducted using Mayfair's standard cycle with a green colorant. This colorant is designed to be mixed at a 4% ratio. We started out with a 1% ratio and went up by 1/2% at a time until 4% was reached. At each colorant level we examined three things. First we checked the paddle for streaks. Next we examined a mark on the paddle where

SCREWS

the core was removed. With proper mixing this mark is not visible. Finally, we used a BYK-Gardner colormeter to record the level of color visible on the surface of the screw.

When testing for streaks/swirls, four screws were able to produce an error free part at a 1% color ratio! The four screws are produced by Glycon, Milacron, New Castle, and Spirex. Keep in mind, that with the normal general purpose screw, the molder was experiencing problems with a 4% ratio.

Test two for color mixing consisted of a visible inspection of a mark on the part. We wanted to see at what colorant level this mark would disappear. Three screws were able to make this mark disappear at the 1% colorant level. These screws include: Advanced Technologies, Milacron, and Xaloy. Milacron produced the only screw that was able to remove the mark and swirls at a 1% color ratio.

The final test consisted of a color measurement. This data is frankly a little hard to understand at first glance. The color measurement unit uses a Y,x,y measurement format. With this format a darker green has a lower "Y" number and higher "x" and "y" numbers. This is still incredibly confusing when looking at all three numbers at once. Thus, we subtracted the "x" and "y" values from the "Y" to come up with one number. The lower this number, the higher the level of green. For our purposes, we'll call it the "green number".

With this number averaged for all color levels, it becomes apparent that the Milacron produces the brightest green on the surface, followed by Westland and Spirex. At the low concentrate levels (2% and below) Milacron, Westland, and New Castle had the brightest green on the surface. At the high concentrate levels (3% and above) Westland, Advanced Technologies, and New Castle had the brightest green on the surface.

Overall, the data shows that Milacron had the best screw for mixing. Spirex also exhibited excellent mixing ability. Many of the other positions are varied depending on what data you look at. For instance, Westland did very well in the surface brightness of the green, but did not fair quite as well in the swirl and mark tests. Many screws did well in one area, but not as well in others.

Note: It is important that everyone understand that there is a direct relationship between mixing and throughput. The most effective mixing designs utilize some type of restrictive device to alter the polymer flow. This will obviously affect throughput. Thus, the perfect screw design optimizes mixing without compromising throughput. Easier said than done.

Throughput and Output Rate- This variable was measured using several different methods as well. The simplest method is to simply use the molder's cycle and optimize it based on cutting the cooling and plastication times. We set a guideline around the heat deflection temperature of the part, which, in this case, is 216 degrees Fahrenheit. If the surface temperature of the part is above this setting, as measured by an IR Gun, the cooling time must be added. The lowest cycle time with an adequate part temperature is recorded. This is test one.

Test two consists of backing away the barrel and turning the backpressure and RPM's to maximum. Then the screw is plasticated, purging the material from the barrel at a high rate. PPR records the maximum RPM at which solid pellets do not appear from the tip of the nozzle. The final variable rounding out this evaluation is the plastication time at maximum RPM as measured using the molder's cycle. This is straightforward, the shorter the plastication time, the greater the throughput can be.

In the cycle time portion of the test, Westland had the shortest cycle time, followed by Advanced Technologies, and Xaloy. Not surprisingly, the plastication times show the same results, with the same leaders. The last remaining test is the "solid pellet test". This test has the exact opposite results (other than Xaloy) of the other two tests. Four screws were able to achieve zero solid pellets at 200 RPM. These screws were Xaloy, Glycon, Milacron, and Spirex.

This seems odd at first, but upon further review it makes sense. The screws with the least amount of restriction to flow will produce the lowest plastication times, and therefore, the lowest cycle times. However, these screws will also not produce as much shear heat during plastication, and thus they will not melt the solid pellets as easily. Likewise, screws with a longer plastication time are more likely to melt the solid pellets.

Hydraulic Energy Consumption- This is a measure of the energy consumed by the machine, excluding the heaters. In this way we can isolate the energy needed for injection and plastication, and thus, screw torque. In this test, Spirex used the lowest amount of energy, closely followed by Glycon. From there, the rest of the pack was tightly grouped.

Heater Energy Consumption- This is measured by examining the duty cycle of the molding machine. The duty cycle is the amount of heater capacity used to keep the barrel at the desired temperature. In this case, Glycon had the lowest amount of heater consumption followed by Milacron.

and Xaloy. Keep in mind that this is largely a measure of shear. The less shear heat created, the more the heater bands will be on. Thus, it is logical to assume that the Westland screw produces the least amount of shear, followed by Advanced Technologies and Spirex. This correlates with the throughput tests as well.

Melt Temperature- Melt temperature is measured during an air shot using the 30/30 method and a pyrometer. In this test, Milacron had the lowest temperature, followed by Glycon, New Castle and Xaloy.

Conclusions

First off, there is a lot of information here. But, there should be in a test that took eight months to setup. We hesitate to make too broad of a recommendation because of the varied nature of the data (different companies did well in different areas), but we can easily give you who performed best in certain categories. Milacron's screw performed the best in our mixing test while exhibiting the lowest melt temperature. The duty cycle analysis of the heaters suggest that Westland produces the least amount of shear. Westland also produced the greatest throughput. The motor energy consumption shows that the Spirex screw used the least amount of pump horsepower, and, therefore, screw torque.

Several of the other screws fared near the top in some areas, but not so near in others. If you like, you can rank each screw from 1 to 7 in each category and come up with a composite number. We hesitate to do so, because you may want to weight certain categories above others.

One definite conclusion that can be drawn is that changing the screw has an effect. All seven screws fixed the molder's problem. In fact, if the molder changes screws, they should be able to run successfully with a lower level of colorant. This would save a tremendous amount of money over time. Also note that the molder's general purpose screw had problems at 4% colorant while several of the screws in this test ran well with a 1% colorant level.

When analyzing the data you will also notice that a screw was either good at mixing, or throughput, but never both. For instance, the great mixing screws presented by Milacron and Spirex did not fair as well in the throughput portion. Meanwhile, the high throughput screws presented by Westland and Xaloy did not fair as well in the mixing sections. Two screws were mid-to-upper echelon in both areas. Although they were not first in either area, they did well in both. These screws were presented by Advanced Technologies and New Castle Industries. The screw presented by Glycon also performed right in the middle in both aspects. It takes some thought to

really understand it, but all of the data here is interrelated in some way.

So, what can you draw from all of this? If mixing, not throughput, is your main concern, go with Spirex or Milacron. If you want mixing, but particularly need throughput, look to Westland and Xaloy. If you want a nice solid combination, Advanced Technologies would be your bet, followed closely by New Castle and Glycon. Again, we cannot stress our main conclusion enough. You spend \$250,000 on your molding machine, why not spend \$4000 on your screw! The performance difference between the screws shown in this test, and the one that came with the machine, is enormous.

SCREWS

	GLYCON	SPIREX	WESTLAND
Model	Barr-E.T. Screw w/Infuser	Pro Barrier w/Z Mixer	The Eagle
L/D	24:1	24:1	24:1
Compression Ratio	3.5:1	2.46:1	3.2:1
Price	N/A	\$6,500	\$5,165
Test Results			
Mayfair's Mixing Problem	Fixed	Fixed	Fixed
Hydraulic Energy Consumption	11.07 kWh	10.80 kWh	11.53 kWh
Melt Temp.	7.42%	9.07%	10.46%
Mixing	378	381	383
Lowest percentage colorant W/O swirls	1.00%	1.00%	2.00%
Lowest percentage colorant W/O mark	3.00%	1.50%	1.50%
Color (0 psi backpressure)			
4.00%	6.2260	5.7806	5.6984
3.50%	6.3383	6.0038	6.0002
3.00%	6.1764	6.1763	5.9714
2.50%	6.2468	6.2575	6.6407
2.00%	6.7421	6.7011	6.7825
1.50%	6.5688	6.4792	6.7837
1.00%	7.6306	7.7724	6.9219
Average Color Level (lower the better)	6.2469	5.9869	5.8900
Throughput			
"Solid Pellet Test"	200 RPM	200 RPM	130 RPM
Cycle Time (seconds)	54.335	55.405	53.010
Recovery Time (seconds)	8.340	8.955	6.704

ADVANCED	XALOY	MILACRON	NEW CASTLE
The Hopscotch	X-201 Mixer	MELTSTAR w/Spiral Mixer	Stratablend
24:1	24:1	24:1	24:1
2.5:1	3.2:1	3.1:1	3.25:1
\$3,600	\$3,897	\$3,600	\$4,836
Fixed	Fixed	Fixed	Fixed
12.14 kWh	11.96 kWh	12.0 kWh	11.53 kWh
9.97%	8.24%	7.69%	8.84%
381	378	371	378
2.00%	2.50%	1.00%	1.00%
1.00%	1.00%	1.00%	2.00%
5.6558	5.6871	5.9709	5.7993
5.9594	6.0348	6.2123	5.9301
6.1828	6.4161	6.1723	6.1463
6.7285	6.9838	6.2020	6.5063
6.8995	7.2330	6.3736	6.5678
7.0821	7.6682	6.8186	6.8825
7.2816	7.7821	6.9584	7.4563
5.9327	6.0460	6.1185	5.9586
80 RPM	200 RPM	200 RPM	150 RPM
53.290	54.110	56.640	54.710
6.810	7.955	8.480	7.505

WHAT WE TEST

Mayfair's Mixing Problem- A real life problem in which a molder has to eat cycle time to fix swirling and streaks on the surface of a part. Can these specially designed screws fix this problem?

Mixing- Mixing is always an issue, particularly when molding with color. The better the mix, the better the color uniformity. Mixing also decreases the chances of surface defects on the part.

Throughput and Output Rate- Throughput is an issue in jobs where molders are running fast cycle times. If your cycle is limited by plastication time, this is a prime area of concern.

Hydraulic Energy Consumption- A measure of the energy used by the molding machine to plasticate and inject. These test results show that screw design can have an effect on the horsepower necessary for these tasks. It is also a direct relation to screw torque.

Heater Energy Consumption- This is directly a measure of the energy necessary to heat the barrel. It also tells something more important. The greater the amount of heater usage, the less the amount of shear heat created by the screw. More heaters, less shear. More shear, less heaters. Shear is an important consideration in material stress and degradation.

Melt Temperature- This is a direct indication of the shear heat introduced into the polymer.

HOW WE TEST

Mayfair's Mixing Problem- A relatively easy thing to test. Mayfair runs several colors on this job, but has streaking and swirling problems with the green and must increase the cycle time. We run the standard cycle time as a baseline and then change the screws. With the 4% colorant ratio run by Mayfair we test to see if the streaking and swirling is fixed. This is done via a visual examination as it is easy to spot.

Mixing- Mixing is tested in three different ways in our test:

Streaking and Swirling- This test is conducted by using the molder's part and cycle setup. The colorant level is started at 1% and then increased by .5% at a time until the streaking and swirling disappears into a solid color. It is possible, as shown in this test, for a screw not to exhibit any streaking and swirling even at concentrate levels as low as 1%. The percentage at which the streaking and swirling ceases is recorded.

Mark Test- The part has a mark created by a core. This mark is only visible if the color of the part is too light or not properly mixed. Starting with a percentage of 1%, as described above, we find the percentage at which the mark disappears.

Color Meter Test- As the colorant level is increased in the above test, a surface color reading is taken at each colorant level from 1 to 4%. The BYK-Gardner color measurement unit measures the color in a Y,x,y, format. The lower the "Y" and the higher the "x" and "y" values the greater the level of green. To obtain one number we subtract the "x" and "y" from the "Y". This number is the "green number". The lower the "green number", the greater the amount of green on the surface. Remember, lower equals better. This number is averaged for all percentage levels so that you can determine an overall winner. Keep in mind that this portion of the test is only a measure of how well the screw is able to produce color brightness at the surface.

Throughput and Output Rate- This is also tested in three different ways:

Cycle Time- The simplest method is to simply use the molder's cycle and optimize it based on cutting the cooling and plastication times. The lower the cycle time the better. We set a guideline around the heat deflection temperature of the part, which, in this case, is 216 degrees Fahrenheit. If the surface temperature of the part is above this setting, as measured by an IR Gun, cooling time must be added. The lowest cycle time with an adequate part temperature is recorded.

Solid Pellet Test- Test two consists of backing away the barrel and turning the backpressure and RPM's to maximum. Then the screw is plasticated, purging the material from the barrel at a high rate. The purge is examined for solid pellets. PPR records the maximum RPM at which solid pellets do not appear from the tip of the nozzle.

Plastication Time- The final variable rounding out the throughput test is the plastication time at maximum RPM as measured using the molder's cycle.

Hydraulic Energy Consumption- This is measured during a five minute run using the molder's standard cycle. All energy consumed by the machine, except for the heats, is monitored and recorded.

Heater Energy Consumption- This is measured during a five minute run using the molder's standard cycle. The percentage of heater usage for each of the four zones is recorded as it changes over the testing period. This value is taken directly from the machine controller. An average percentage of heater usage is determined by averaging all values for all four zones.

Melt Temperature- The melt temperature is monitored by injecting into the air and then inserting a thermocouple into the melt. The 30/30 rule is followed in this test to ensure an accurate melt temperature reading.

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DESIGN QUESTIONNAIRE

PLEASE RETURN BY FAX TO: (321) 783-0103 – ADVANCED TECHNOLOGIES WORLDWIDE, INC.

1. SCREW DIAMETER: _____ L/D: _____
2. PRESENT PROFILE (IF AVAILABLE)
_____ TURNS FEED @ _____
_____ TURNS TRANS _____
_____ TURNS DISCHARGE @ _____
MIXING SECTION _____
_____ TURNS DISCHARGE @ _____
OTHER: _____

3. END PRODUCT: _____
4. MATERIAL DATA: SPECIFIC GRAVITY, MELT INDEX, MELT TEMP., REGRIND % FILLERS)

5. ACTUAL OUTPUT: _____ / LBS / HOUR SCREW RPM _____
6. DESIRED OUTPUT OR RECOVERY TIME: _____
7. TEMPERATURE PROFILE: _____
INJECTION PROCESSES:
A. SHOT SIZE / CU. IN. / OZ. _____
B. CYCLE _____
C. RECOVERY TIME _____
D. STROKE LENGTH _____
E. TONS _____
8. COMMENTS /EXISTING PROBLEMS WITH YOUR PROCESS:

9. PLEASE PROVIDE US WITH YOUR INFORMATION AS WELL AS OUR CONTACT PERSON.
1. COMPANY NAME: _____
2. CONTACT NAME: _____
3. TEL: _____ FAX: _____ E-MAIL: _____

THANK YOU ONCE AGAIN FOR YOUR INTEREST IN OUR COMPANY – WE WILL IMMEDIATELY BE IN CONTACT WITH A DETAILED ANALYSIS OF YOUR PROJECT.

**ADVANCED
TECHNOLOGIES
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QUOTES

IF YOU SHOULD REQUIRE ANY QUOTES FOR REPAIR OR MANUFACTURE OF YOUR SCREWS AND BARRELS, PLEASE USE THIS FORM AS YOUR MASTER AND SEND US VIA FAX THE INFORMATION AVAILABLE. WE WILL IMMEDIATELY BE IN CONTACT WITH YOUR WRITTEN QUOTE. **ADVANCED TECHNOLOGIES WORLDWIDE, INC. - FAX # (321) 783-0103**

SCREWS	1	2	3	4
MANUFACTURE / REBUILD				
OUTSIDE DIAMETER				
OVERALL LENGTH				
L/D				
MACHINE MAKE				
MIXER - TYPE				
MATERIAL TO PROCESS				

COMMENTS:

BARRELS	1	2	3	4
MANUFACTURE / HONE				
INSIDE DIAMETER				
OUTSIDE DIAMETER				
L/D				
OVERALL LENGTH				
MACHINE MAKE				
MATERIAL TO PROCESS				

COMMENTS:

PLEASE COMPLETE:

COMPANY: _____
 CONTACT: _____
 Email: _____
 TELEPHONE: _____ FAX: _____