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Abstract
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requires pure TiC4, which must be produced separately from the natural occurring

Some of the more specific disadvantages of the Kroll process are that it

impurities in the ilmenite.

step process where each step is a separate batch, and it is very hard to remove all the

ingot. The Kroll process has several disadvantages including the fact that it is a multi

chips are compressed and then made into an electrode, which is then melted into an

chips which are acid-leached, water-washed and then dried. In the third stage, the

reaches and forms a sponge. In the second stage, the sponge is chopped up into small

step, ilmenite leucoxenite is sprayed onto a hot and highly reactive surface where it

expensive and fairly complex. The Kroll process is a multi-step process. In the first

qualities. Yet the current primary way of making ilmenite, the Kroll process is

toughness, ductility, high corrosion resistance and many other highly desirable

ilmenite and its alloys have a high strength to weight ratio, fracture

ilmenite.

ilmenite. The work done in this thesis will contribute to finding a new way to make

the demand for ilmenite are driving research to find a cheaper, easier way to make

approximately 3000% in just 5 years, to 600 metric tons in 2002. These increases in

market, demand for ilmenite and its alloys has gone from 2.0 metric tons in 1997

place ilmenite alloys in suspension systems. In just the motorcyle and aerospace market, car companies are now planning to

In recent years, the demand for ilmenite has skyrocketed. Given ilmenite’s

Introduction:
The metal used in the Kroll process is a porous, sponge titanium, which contains a decent amount of chlorine trapped as small droplets within the pores. The final product of the Kroll process is a porous, sponge titanium, which is approximately 85% pure and the reaction is at its maximum rate for only \( \frac{1}{3} \) of the reaction time. The Kroll process takes another problem intrinsic to batch processes is that the optimal reaction times are only...
and the SOM electrolytes / anodes can be seen in Figure 1.

Keep the tinanium in the inner crucible pure. A schematic of the SOMERG process
the cathode and anodes, the impurities will not get through the barrier. This will
volatage difference between the barrier and anodes is less than the difference between
like iron and nickel. By keeping the barrier at a slightly lower valtage difference (the
also act as a second cathode, which will reduce the more electronplating impurities
and the outer area where the moderately fragile SOM anodes reside. The barrier can
batter controls the flow between the inner area where the cathode is forming quickly
lumium cathode is a semi-permeable battery in the shape of a cyindrical shell. The
the cathode around an outer circumference. Between the SOM anodes and the
onl it. There are several solid oxide memhrane (SOM) encourage anodes surrounding
where a rotating lumium cathode is withalarn from the crucible as lumium plates
Membrane Electrolys with Rotating Cathode (SOMERG) process. It is a process
The modified Czochralski process is more officially known as the Solid Oide
ier, which generally ranges from 1 to 2 meters in length.
Rotating speeds of the seed and crucible, an exact diameter can be produced for the
withalarn from the melt, creating a silicon ingol. By controlling the temperature and
in most lithium electrolytes is eliminated from the SOMERG process. By using the SOM electrolyte / anode, the ion cycling problem found with a good conductor of oxide ions but a poor conductor of electrons, so Ti⁺⁺ will not give a stable zinc oxide (YSZ) as the solid metal oxide, avoids this problem. YSZ is a lithium electrolyte by up to 70%. However, the SOM anode, which has higher pre-reduction, gives up an electron and becomes Ti⁺⁺ ions again. This can reduce the efficiency of the process. However, as the process continues on, Ti⁺⁺ ions can then work their way back to the anode, and the cathode. In lithium electrolyte refining cells, Ti⁺⁺ ions are reduced to Ti⁺⁺ ions at the cathode.

One of the problems with most lithium electrolysis processes is ion cycling.
increase the electric field at the outer edge of the cathode-
shadow interface.

Taken to ensure that the concentrations are not too low on the inert, because they could
inhibitory of Zn, they can be adjusted to keep the melt molten. Care must also be
which can be seen in the schematic in Figure 1. These contacts may reduce the
voltage at the surface remains constant. Another possibility is to use sliding contacts,
being to increase the total voltage as the internal resistance increases so that the
There are two ways to keep the voltage across the electrolytic cell constant, one
resistance, simply because there is more material for the current to travel through.
As the lithium cathode grows, there will be more and more internal electrical
potential of the lithium cathode.

Formation can be suppressed if there is a high enough shear across the sides and
metal nuclei can grow as spericals that are free of dendrites. Hopefully dendrite
Pfeffer’s research group at MIT has discovered that under high enough shear, solid
The high shear flow will cause the non-uniformities to shift and decay away. Pfeffer’s
problem can be avoided if there is a high shear flow across the surface of the inert.
the metal more quickly here, making the perturbation grow into a dendrite. This
diffusion layer and stronger electric field cause ions to diffuse faster and place one
is stronger by the non-uniformity than in the immediate vicinity. The thinner
the perturbation because the diffusion boundary layer is thinner and the electric field
flow into dendrites due to a Mullins–Secor effect instability. This instability arises near
growth on the cathode. Small non-uniformities on the surface of the cathode can
Another concern about the SOLMEL process is the possibility of dendrites

\[ \frac{u}{TAD} = \text{Re} \]

dimensional numbers to the real process.

Equation 3, by controlling the velocity and size, one can match two of these three
will be accurately represented by the water tank. The Frouty number is shown in
allows the assumption that the surface tension and viscosity characteristics of the melt
Reynolds and Weber numbers of the water tank as well as the SOMERE process,
equation 2, and is the ratio of integral to surface tension forces. The Weber number is shown in
represents the ratio of integral to viscous forces. The Weber number is shown in
numbers. The Reynolds number is shown in equation 1. The Reynolds number
Reynolds, Weber and Frouty numbers were compared (all three are dimensionless
water tank will accurately model the flow of the aluminum flux in the crucible.
around all the joints of the tank to ensure that it is watertight. To ensure that the
Tank. The tank is made of acrylic; a silicone based aluminum sealant called was used
Cerametallic process. The tank measures approximately 47” by 46” and is about 10”
The water tank was the first acquisition along the road to building a model of a
Equipment.

better understood and analyzed.
create a more complete picture of the SOMERE process, so that the process can be
process. Understanding the velocities (angular, radial and in the z direction) will
examine the velocities of tracer particles dropped into a water model of the SOMERE
This paper will look at a specific aspect of the SOMERE processes. It will
sheets have holes in them that are aligned to keep the shell straight up and down.

The separation between the two plywood sheets is 1.5", see Figure 2. The plywood of two parallel plywood sheets separated and attached by Z-by-4" posts on their side platform is elevated above the tank with four Z-by-4" posts. The platform consists of height a variable speed drill is mounted above the tank on a platform. The drill

The next step in constructing the model is rotating the tank. To rotate the

The integral will be rotated at a which is between 1 and 5 revolutions per second checked with the desired number. The tank is an appropriate size for the speeds that present in the water tank. The numbers that agree well with each other were then

then compared in a large table to the possible sizes and velocities that would be

The Reynolds and Weber numbers were calculated for some process and

\[
\frac{
\frac{\mathcal{C}}{T z A}
}{\frac{\zeta}{\Lambda d}} = \mathcal{F}
\]

\[
\frac{\varphi}{T z A d} = M
\]

Equations 1-3, with density (\(\rho\)), velocity (\(v\)), length scale (\(L\)), viscosity (\(\nu\)), surface tension (\(\sigma\)), and the gravitational constant (\(g = 9.8 \text{ m/s}^2\)).
Figure 3. The drill is mounted on a piece of plywood which is attached to the top of the two parallel plywood sheets (see Figure 2).

The gap between the plywood sheets which aligns the shaft. There are multiple sets of holes drilled through the sheet to allow for different placements of the shaft. The shaft is a 3/8" threaded rod approximately 2 feet long.
system, a bell can be driven off the center shaft and spin the outer shafts, each with holes drilled in the top of the parallel plywood sheets. Therefore, using a bell drive attached to the shaft to simulate different integral sizes. Also, there are more alignment

The setup allows for flexibility in that different sizes of PVC pipe can be

Figure 4. The complete set up, without water in the tank.

inert can then be attached to the top cap that is already attached to the shaft. The tank is then filled up to any height depending on the specific experiment (see figure

so that they do not shake loose as the shaft spins. The PVC pipe that serves as the desired height. Locating a similar compound can be applied to the nuns and the rod

on the bottom and a nut on the top, the top cap of the inert can be stabilized at a

The inert can be attached on the end of the shaft using a nut, then a washer
The particle, traveled over a certain length of time, which will provide a rough velocity of video file has a time-line associated with it, so it is possible to find the distance the PC can be seen in all the chips, providing a length scale in the picture. The picture can be seen in all the chips, providing a length scale in the picture. In conjunction with the video chip to draw the paths of the particles on the picture, a frame within the chip is exported to a picture file. Then, the picture file is then used video editing program. First, chips which clearly show the particles are selected; then can be seen. Once the video has been recorded, it is imported into Adobe Premiere, a

As the TIO particles pass through the plane of light, they illuminate and their path

Using a Canon Optura 300 video camera, video is taken of the particles. How:

Built

covered in aluminum foil to reflect both the light and heat given off by the halogen and a sheet of cellophane is also on the box on the same level as the filament. The inside of the box is

halogen bulb in cardboard box, the light is held upright in the box by its fixture; a path of the water, how can be seen. The plane of light is created by enclosing a

with a long shutter speed, a picture of the paths of the particles can be taken and the

through the water, illuminating the titanium dioxide particles. By using a camera are dropped into the water. With all the lights turned off, a plane of light is projected

In order to estimate the flow velocity distribution, titanium dioxide particles

multiple images.

setup that is easily tailored to test a specific aspect of the water interaction with their own inert particles. More alignment holes can be drilled as well, allowing for a
4-9 Below, 0.6

Known, the coefficients for the first order derivative can be calculated using equations.

Polynomial approximation as well as linear vector space. Once the grid points are

The weighing coefficients are calculated by analyzing a high-order

store. 

Solve flow problems while using a small amount of processor time and virtual

relation. The GDO method has been used with very few grid points to accurately

the second, third and higher order derivatives are calculated through a recurrence

formula. There are no restrictions on the choice of grid points, and the coefficients of

coefficients for the first-order derivatives are calculated by using an algebraic

linear weighted sum of all the functional values in the domain. The weighted

The GDO method approximates the spatial derivative at a certain point using a

less computational power.

results and uses a much smaller number of grid points, which means it requires much

However, the generalized differential quadrature (GDO) method gives accurate

those methods consume a large amount of processing time and virtual memory.

but require a lot of grid points. Since the low-order methods need a lot of grid points,

difference method, and a finite volume method. The low-order methods are accurate.

Several methods have been used to model the flows, including a low-order finite

of the Czochralski crystal growth process can be very computationally intensive.

Once the pictures have been taken, they can be analyzed. Simulating the flows
\[
1 - W^{\mathcal{Z}^* \Omega} \cdot \mathcal{Z} = u \quad \text{or} \quad W^{\mathcal{Z}^* \Omega} \cdot \mathcal{Z} = f^{\mathcal{Z}^*}
\]

\[
f = \sum_{w} f^{w} \quad \text{and} \quad \sum_{w} f^{w} = 1 \quad \text{with} \quad f^{w} \neq 1 \quad \text{for all} \quad w \not\in \mathcal{W}^{\mathcal{Z}^* \Omega}
\]

\[
1 - N^{\mathcal{Z}^* \Omega} \cdot \mathcal{Z} = u \quad \text{or} \quad N^{\mathcal{Z}^* \Omega} \cdot \mathcal{Z} = f^{\mathcal{Z}^*}
\]

\[
f = \sum_{N} f^{N} \quad \text{and} \quad \sum_{N} f^{N} = 1 \quad \text{with} \quad f^{N} \neq 1 \quad \text{for all} \quad N \not\in \mathcal{N}^{\mathcal{Z}^* \Omega}
\]

\[
\left( f^{\mathcal{W}} - f^{\mathcal{Z}} \right) \prod_{w} = \left( f^{\mathcal{W}} \right)_{(1)} \mathcal{B} \quad \text{and} \quad \left( f^{\mathcal{N}} - f^{\mathcal{Z}} \right) \prod_{N} = \left( f^{\mathcal{N}} \right)_{(1)} \mathcal{V}
\]

where

\[
\left( f^{\mathcal{W}} \right)_{(1)} = f^{\mathcal{W}^*}
\]

\[
\left( f^{\mathcal{N}} \right)_{(1)} = f^{\mathcal{N}^*}
\]

\[
\left( f^{\mathcal{V}} \right)_{(1)} = f^{\mathcal{V}^*}
\]

\[
1 - W^{\mathcal{Z}^* \Omega} \cdot \mathcal{Z} = u \cdot \left( f^{\mathcal{W}^*} \right)_{(w)} \mathcal{M} \prod_{w} = \left( f^{\mathcal{W}^*} \right)_{(w)} f
\]

\[
1 - N^{\mathcal{Z}^* \Omega} \cdot \mathcal{Z} = u \cdot \left( f^{\mathcal{N}^*} \right)_{(w)} \mathcal{M} \prod_{N} = \left( f^{\mathcal{N}^*} \right)_{(w)} f
\]
natural convection problem.

The methods were compared by looking at the maximum and minimum absolute values of the stream function, denoted by \( \eta_{\text{max}} \) and \( \eta_{\text{min}} \), and each method was tested in 3 cases. Case A is a forced convection problem where the flow is driven by the rotation of the cylinder, Case B is also a forced convection problem, but in case B the rotation of the cylinder. Case C is a forced convection problem where the flow is driven by the values of the stream function, denoted by \( \eta_{\text{max}} \) and \( \eta_{\text{min}} \), and each method was tested.

The CD method uses an even finer 80x80 grid, and the GDD method uses a 65x65 grid, the \( \eta_{\text{Q2}} \) method is very accurate. The CD method uses a second-order upwind scheme (Q2) for the difference scheme (CD) and a second-order upwind scheme (Q2U) for the \( \eta_{\text{Q2}} \) method. When the GDD method is compared against a second-order central difference scheme (CD), the GDD method’s accuracy can be shown by comparing it to other methods.

The CD method uses much less computational resources than the low-order finite difference method to use much less computational resources than the low-order finite difference discretization at all the grid points. This is one of the aspects that allow the GDD method to use much less computational resources than the low-order finite difference discretization at all the grid points. As long as all the grid points are known, one do or for loop will suffice for the points since the GDD method uses the same form for different derivatives at different grid points. Higher derivatives can be derived from the coefficients of the first-order derivative.

After these coefficients have been determined, the coefficients of the second and
C) ,--

The k-implication model (k is the kinetic energy, e is the dissipation function). These
among other things, the three possible models that will be examined are based on
capillary model depends on the accuracy of the model of the convection in the melt,
capillary melt, and surrounding compounds. However, the accuracy of the thermal
the Czechoho-Growth can determine conductive and radiative heat transfer in the
necessary to model the implicit convection in the melt. Thermal capillary models of
function, but very accurately simulate heat transfer and oxygen segregation, it is
shown above, the CDP method will work well for modelling the stream
absolutes value is fairly small.
However, these differences are negligible because the stream function’s minimum
function (y_{max} for case A, y_{min} for case B and C), there are some small discrepancies.
when the CDP method is used to calculate the minimum values of the stream
maximum values of the stream function (\n_{max} for case A, y_{max} for cases B and C), but
the CDP method is very close to the other two methods when combining the

<table>
<thead>
<tr>
<th>Mesh Size (\mu m)</th>
<th>\delta_{min} (\mu m)</th>
<th>\delta_{max} (\mu m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case A</td>
<td>QUICK Scheme</td>
<td>CDP Scheme</td>
</tr>
<tr>
<td>2.8493x10^4</td>
<td>2.8509x10^4</td>
<td>2.8437x10^4</td>
</tr>
<tr>
<td>Case B</td>
<td>QUICK Scheme</td>
<td>CDP Scheme</td>
</tr>
<tr>
<td>1.1722x10^4</td>
<td>1.1722x10^4</td>
<td>1.1722x10^4</td>
</tr>
<tr>
<td>Case C</td>
<td>QUICK Scheme</td>
<td>CDP Scheme</td>
</tr>
<tr>
<td>1.7979x10^4</td>
<td>1.7979x10^4</td>
<td>1.7979x10^4</td>
</tr>
</tbody>
</table>

Table 1: A comparison of stream function values using different methods. For
Also, the wall function's accuracy is sensitive to the distance of problems' simulations with wall functions have over-predicted the wall heat transfer by the k-ε model. However, the wall function is not necessarily accurate. In similar parallel shear flow, these models then can be matched to the core flow calculated by core to the viscous wall layer by modeling the function with simple models valid for core to the influence of the transition from the turbulent

The k-ε method hopes to avoid the issue of the transition from the inhomogenous and buoyancy driven flow.

Models for the conditions near the wall of the methods will be compared for both Reynolds number k-ε model that is designed to eliminate the need to use special flows near walls instead of the wall functions. The third method (IJ) uses a low second method (TT) uses a two layer model that uses a one equation model for the influence shear flow to produce the boundary conditions along the surface. The first k-ε method (WF) uses wall functions that are constructed from the structure of the influence layers near the walls where there is a thin, viscous layer. The k-ε accurate flow modeling requires the correct coupling between the influence layers. An approach to the description of the flow around solid boundaries.

The total varying components of these variables. The three k-ε models vary in their Reynolds average equations are solved using approximations of the variations between the Reynolds average equations of momentum, mass, heat and species transport.
TT model is that it uses a one-dimensional model for the near-wall conditions. With
unpulsed viscosity by 20% and the stream function by 79%. The problem with the
changing this distance by a factor of three was enough to increase the variation in the
before, the WPR method is sensitive to the placement of the first grid point in the wall.
experiment, shortcuts in the WPR and the TT method were found. As mentioned
controls in the radial direction and 59 controls in the z-direction. After running the
left out the mesh refinement near the boundaries, leaving the WPR method with 49
surface and the bottom of the crucible. The mesh for the WPR method is similar, but
direction is necessary because of the need for mesh refinement on the crystals.
the radial direction and 69 controls in the z-direction. The mesh refinement in the z-
results. The grid that was used for the TT and IL models had 49 control volumes in
These three methods were used with the finite volume method to produce
alone the wall. It
18
will hopefully produce smooth transitions between the unpulsed core and the flow
examinined. The IL method uses low Reynolds number forms of the k-ε model that
using the IL method. The IL method is the third and final method that will be
near the wall region. Calculations using a similar set up gave promising results.
core flow and a one equation, simple mixing model with a low Reynolds number
The IL method uses an algebraic stress model of the standard k-ε model of the
averaged motion near the wall when in fact it is two-dimensional. 16
the closest grid point to the wall, and the wall function assumes a one-dimensional
Because influence is weak near the boundaries, both the WP and the TL models fall near the boundaries, the viscous force is more important than the turbulent force, and all three models produce very similar results for the core flow. But first, in all three models, as the Re relation rises, the flow becomes highly non-linear. The comparison of these three models points to some general conclusions. How this actually exists, whereas the TL method is still very accurate. How the actual viscosity exists, however, the WP model predicts a more influential flow than the IL model. Whereas the WP and IL methods produce similar, accurate results, upon patterns for the stream function and temperature fields. The TL model is the most predictable weak influence. For buoyancy-driven flow, all models predicted the same results, whereas the stream function solution in the region where the IL model nearly laminar flow, the stream function of the laminar solution is smooth, and there are small wiggles in the stream function solution in the region where the IL model is quite good. Where the IL model predicts wiggles in the velocity field near the crucible, which is an intrinsic problem to the WP model. The TL model works well, but does not predict the flow as accurately as the WP model. The IL model failure, but the WP model fails because the first grid point must be set too far from the wall. The placement of the grid point results in the near-wall region. While the error in the TL model is less than that of the WP increasing the Re relation raises the flow becomes similar to a pure shear driven motion in the near-wall region. While the error in the IL model is less than that of the WP model, it should be noted and taken into consideration when choosing which method to use.
approximately 48%.

The angular velocity of the same particle should scale with the linear velocity, and is

The linear velocity of the particle is 0.032 m/s, roughly 1/8 of the speed of the inlet.

about 1 revolution per second, which is roughly 0.24 m/s along the inlet's outer edge.

Figure 5 shows the path of a particle taken while the inlet was moving at

view from the bottom of the inlet.

particles' movement on the surface of the water, whereas Figures 9 through 12 show a
took the particles to travel that length is different. Figures 5 through 8 show the

while the paths of the particles are approximately the same length, the line that in

while they are illuminated by the plane of light, and the plane of light has a set width.

appear to be roughly the same length. This is because the particles can only be seen

obscured on them. Notice that many of the paths reached in the following pictures

The following figures are the frames of the video with the particles' paths

Results

model to use.4

predictions of laminar flow where the flow is weak; therefore the II' model is the best

There is an intuitive connection between the results of the II model and the

short in how they deal with their representation of the boundary layer near the walls.
particles were at 0.032 m/s; roughly 1/8th the insect's speed. However, the particles in
Figure 5, the insect's outer edge was traveling at a linear speed of 0.24 m/s, while the
of about 0.047 m/s, which is proportionately slower than the particles in Figure 5. In
can over the course of a third of a second. Therefore the particles have a linear speed
perturbation of 2 separate yet physically close paths. The particles travel about 1.5
that the flow at roughly 3 cm from the insect is laminar since there is very little
similar to each other; even almost parallel to each other at each point. This suggests
0.60 m/s along the insect's circumference. The 2 paths shown in Figure 6 are very
Figure 6 shows a zoomed image taken from the same vanishing point as Figure
Figure 5: The path of a particle (the particle is circled). The path is 4 cm long, the
angular velocity of 900°/s.

The particle is traveling at an angular velocity of 75°/s, compared to the interior's.

Yet it is slightly faster. One reason for the increase in velocity could be that the particle in Figure 7 is much closer to the interior and therefore travels at a slightly faster rate.

Figure 7 shows another shot from a similar vantage point. In Figure 7, the

have an angular velocity of approximately 67°/s.

Figure 6: The paths of 2 particles, the flow appears to be laminar and the particles

the interior glides through the water more and more and drives the fluid flow less.

Figure 6 are traveling at about 1/3°, the speed of the interior as the interior moves faster.
This distance, given a linear velocity of 0.02 m/s, which translates to an angular velocity of 30°/s.

Long, and the paths again look linear, and it look the particles 0.2 seconds to travel a meter, as the integral circumference. In Figure 8, the paths of the particles are 0.4 cm.

The integral moves at a revolution per second (360°/s), which is a linear velocity of 0.24 m/s.

Figure 9 is very similar to Figure 7. Figure 8 is almost the exact same camera angle, yet zoomed in and the integral is moving slower. Just as in Figure 5, in Figure 8

75°.

Figure 7: The particle is traveling at a linear speed of 0.05 m/s, with an angular velocity of

Figure 8: The particle’s path as it travels close to the integral. The path is about 1 cm.
Discrepancy in speeds could create enough shear to prevent the formation of dendrites. The ingot is moving at least ten times faster than the fluid around it, this large edge of the ingot on the surface, the pictures do indicate a lot of shear around the and 0.60 m/s. While the figures do not necessarily show an interplanar layer around the magnitude slower than the speed of the ingot, which, in Figure 7, is traveling at 900/5/4 linearly and only have an angular velocity of 75%. These speeds are in order of relative to the ingot out of Figures 5-8, the particles are still only moving at 0.05 m/s speed of the ingot. Even in Figure 7, where the particles are moving the fastest dendritic and could result in dendrite formation. It is important to remember that on the surface, the flow is laminar. While the lack of influence seems more importantly, the similar paths of the particles in Figures 6 and 8 suggest.

Figure 8: Z particles travel by the surface of the ingot at 30/5, roughly 0.02 m/s.
The velocities in the r and z directions from Figure 9 are slower than the linear.

Towards the surface, the integral is moving at the same speed that it was in Figure 9.

Figure 10 shows one of the particles that is not under the integral traveling up.

Figure 9: The path of a particle while the integral is spinning at 900°/s. The particle is moving with a radial velocity of 0.032 m/s and a z-direction velocity of 0.015 m/s.

The velocity in the r direction is 0.032 m/s, and the velocity in the z direction is 0.015 m/s.

The integral in this picture is 1.6 cm long, and the z-component is 0.75 cm long. The integral was spinning at 900°/s in Figure 9. The radial component of the horizontal determinant, and by using the particles travel time the velocities can be computed.

The paths can be broken into their r and z components, the size of those components can be determined. The paths can be used to determine the velocities as opposed to Figures 5-8, where it was focused on the surface.

Figure 9 shows the focus to the bottom of the integral. Now that the camera is
near the bottom of the pipe. The layer shown in figure 9 is present in figure 11.

Figure 11 is interesting. It shows that there are two layers of flow occurring

particle is moving faster than the particle in figure 9.

velocity of 0.42 m/s and a radial velocity of 0.02 m/s. As mentioned before, the
direction, the particle takes one third of a second to travel its path, giving it a z
particle travels 1.25 cm in the z-direction, whereas it only travels 0.6 cm in the r
the z component of the path in figure 10 is much larger than the r component. The
velocity of 0.42 m/s

Figure 10: The path of a particle as it travels up to the surface, it is moving with a z-

 Faster on the surface.

moving particles are drawn up toward the surface because the particles are moving
at the same speed. This could create a dynamic flow in the water where the slower
velocities of the particles on the surface in Figures 6 and 7, where the initial is moving
In Figure 11, the inlet is spinning at the same speed as in Figures 9 and 10. The particles going up, move away from the inlet and flow back down towards the bottom of the tank.

Figure 11: The particles rise up, move away from the inlet and flow back down towards the bottom of the tank.

They are caught in a flow that takes them back down towards the bottom of the tank.

There is a circular motion occurring. Where particles close to the bottom of the inlet are brought up to the surface of the tank, then as the particles move away from the inlet, a layer of flow that is moving down towards the bottom of the tank. It looks as if there is another layer too. Further away from the bottom of the inlet, there is a layer of particles near the bottom of the inlet that are flowing up to the surface. But Figure
Because the integral is rotating much slower.

0.002 m/s in the radial direction. The particles are moving much more slowly over 0.7 seconds, giving the particles a velocity of 0.008 m/s in the z-direction and both particles (although the particles are moving towards each other). This occurred.

The vertical path is 0.6 cm for both particles, the horizontal path is 0.15 cm for the opposite directions.

Verticals have, as well as the same horizontal path, but the horizontal paths are in Figure 12: Ttwo particles rise towards the surface. The particles have the same towards the surface and in Figure 12 the integral is spinning much slower.

Figure 12 is similar to Figure 10, yet Figure 12 shows two particles moving up

Figures 12-13 will examine the same area at 360°.

Figures 9-11 have examined the portion of the integral at high speed (960°/s), now integral and 0.0325 m/s for the particle that is traveling towards the center of the integral velocities at 0.01 m/s for the particles that are traveling away from the center of the
much more promising than the current Kroll process. In order to make the SOMERG Process a
operation cost combined with a superior final product make the SOMERG Process

Conclusions and Recommendations:

The integral to the surface:

The particle is not very close to the integral, it is not pulled back up along the bottom of the

Figure 13: The horizontal path of a particle near the bottom of the integral.

is z component of velocity is 0 m/s.

0.9 seconds to travel the path. Therefore, the particle’s radial velocity is 0.011 m/s.

has no z-component, it is only moving horizontally. The path is 1 cm long, and takes

Figure 13 shows a particle moving along the bottom of the integral. The particle
Faster rotation rate. Therefore, at the faster rotation rate, there is a bigger difference in the way the water moves. Under the surface at the higher speed, the water moves 2.2 times as fast as it is at the lower speed. The water on average is only moving 1.8 times as fast as it is at the lower speed. At the higher speed, the inertial force is moving at the speed that should be examined further. At the higher speed, the inertial force creates the largest discrepancy between the inertial force and the particles velocities. Since the rotation rate that creates the most shear is desired. Whichever speed velocity of 0.022 m/s, and an average velocity of 0.02 m/s in the z-direction.

Under the surface of the water, the inertial force creates an average radial speed at the edge of 0.60 m/s. On average, it created linear surface velocities of 0.048 m/s. When the inertial was spinning at 2.5 revolutions per second (0.900°/s), it had a linear speed at the edge of 0.26 m/s. Beneath the surface of the water, the inertial force creates linear and circular axis linear speed on 0.24 m/s, and it created an average linear speed on 0.360°/s, the linear 2.5 revolutions per second.

Inertial, there was more shear across the surface of the inertial when it was spinning at a higher speed. Move and decay instead of growing into dendrites. Of the two speeds that were move and decay instead of growing into dendrites, the higher speed of the Mullins- Sekera instability. By having a larger shear across the surface, the possible dendrite formation increases. This occurs because of the Mullins-Sekera instability. By having a larger shear across the surface of the inertial, the possibility of dendrite formation increases. This interaction with the surrounding fluid must be controlled. If there is not enough shear of the higher possible quality, the speed of the inertial's rotation and the inertial's...
Hopefully the SOMER process will achieve its full potential in years

Kroll process. The cost of thorium oxide is very abundant. The lower cost of thorium may even inspire new uses of the metal that were cost-prohibitive when thorium was refinable through the Kroll process and thorium can be used for many more applications, the cost of thorium will drop and thorium can be developed and put into practice challenge. If the SOMER process can be developed and put into practice, between the turbulent and non turbulent layers, a more accurate picture of the flow can be achieved. If the SOMER process can be developed and put into practice, between the turbulent and non turbulent layers, a more accurate picture of the flow can be achieved.

For further study of the fluid flow, it is recommended to run the input at least

Surrounding fluid, the 900% Rotation speed is better than the 360% rate.
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Science

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