

TTNA, FSAA Melbourne, Australia

Balancing Mineral Processes

Trevor Sparks
solid-liquid-filtration.com/resources

25/08/2011

filter-ability™



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Introduction

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filter-ability

Anyone speak Welsh?

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Outcomes – what do they mean?

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└ Introduction

└ Anyone speak Welsh?

Anyone speak Welsh?



The sign-printing company would send the signs to a translation office by e-mail...

Apparently, it says "I am not in the office at the moment. Send any work to be translated"

Outline

- Balancing mineral processing
- *What the filter man should know about theory* Frank M. Tiller 1974
- Some examples and possible approaches to problems.



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└ Introduction

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- Balancing mineral processing
- *What the filter man should know about theory* Frank M. Tiller 1974
- Some examples and possible approaches to problems.

Framing the success of a production process/ company

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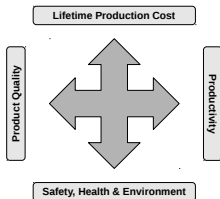
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└ Framing the success of a production process/ company

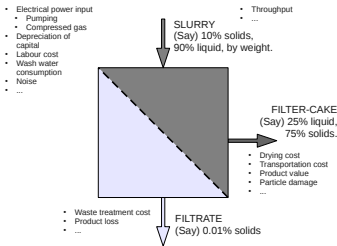
Framing the success of a production process/
company



No matter what you produce, if you are ahead in all of the above four dimensions of success, you are the market leader.

One may come at the expense of the other (you may aim for a higher quality market, but can hardly expect your costs to reduce at the same time).

Filtration outcomes...



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Filtration outcomes...

Filtration outcomes...



There are a number of outcomes from a filtration process, and these can impact (either directly or indirectly) upon the four dimensions of success. For example, a cake moisture of 20% w/w versus 18% w/w:

- Effect on drying costs
- Effect on dryer throughput
- Effect on transportation – safety, dusting, number of trucks needed ...

This is a very useful exercise – relating the outcome of your filtration process to the overall success of your process and performing a sensitivity analysis.

We know, pretty well, what determines performance

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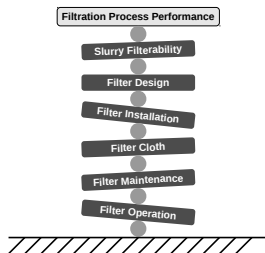
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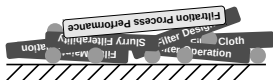
We know, pretty well, what determines performance



You can do something about each of these layers, although the time and effort needed may vary. For example:

- Changing an Operational parameter can be done immediately
- Changing a filter Cloth might take a few weeks – contacting vendors, small scale trial then plant trial
- Changing a filter Design might take a week or so (adding a baffle plate) or a couple of years (a new filter)

But each layer can veto this performance



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└ But each layer can veto this performance

But each layer can veto this performance



No matter how good every other success-factor, if one is out of whack then the whole thing tumbles over. This is where knowledge of the overall filtration process comes in – understanding all of the success factors, dealing with excursions.

The life-stages of a production process

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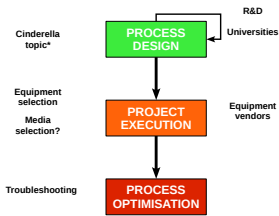
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* Derek Purchas/
Richard Wakeman



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The life-stages of a production process

The life-stages of a production process



It may take five to ten years for a product to begin production after the discovery of a resource, or the patenting of an active pharmaceutical ingredient.

Most of the processes in R&D do not become production processes.

The purchase of large-scale solid-liquid filtration equipment in pharma, mining & chemical processing is around €2 billion per year.

During this time, a large number of decisions need to be taken. If one of these decisions affects the production cost, quality etc. by fifty cents a tonne, then over 20 years

The days when large process industry players had specialised filtration and separation knowledge are disappearing.

What should the filter engineer know/ have?

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Outline

- What *sort* of things happen in solid-liquid suspensions – particle-particle & particle-cloth interaction.
- What a filter-cake is, how it forms. How air-displacement (expression) and cake washing proceed.
- How micro- and macro-scopic phenomena and features affect the production rate and quality.
- The ability to test ideas, preferably at the lab-scale
- What technologies are available – filter-media & filter equipment (order?).
- Where to get more information, how to deal with filter media, filter-aid and filtration equipment companies.
- How the outcomes of filtration processes affect the overall success of their process.

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└─What should the filter engineer know?

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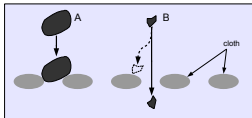
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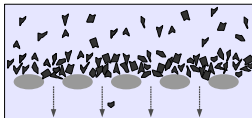
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Just for example

A single particle



Many particles



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Just for example

A single particle

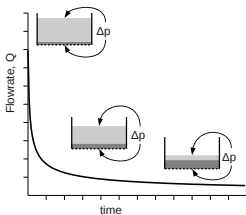


Many particles



Flow vs. time (constant Δp)

This is what determines capacity



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└─What should the filter engineer know?

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Flow vs. time (constant Δp)

This is what determines capacity



Cake variations

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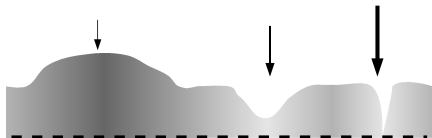
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What is causing them, what harm are they doing?



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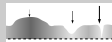
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└─What should the filter engineer know?

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Cake variations

What is causing them, what harm are they doing?



How cake moisture affects things.

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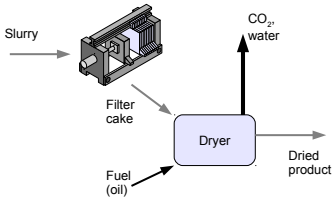
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└ Outomes – what do they mean?

└ How cake moisture affects things.

How cake moisture affects things



Conclusions

- Alumina 70 million tonnes per year → 8000 tonnes per hour.
- Typical moisture before calcination $\approx 7.5\%$ wt/wt
- What if we can get 6%?
- Well ...
 - Say US\$50 million (depending upon the price of oil).
 - 500,000 tonnes less CO₂



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└ Outcomes – what do they mean?

└└ Back of an envelope

Back of an envelope

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Equally

Suppose you are limited by evaporative capacity.

Row	Column	Value	Unit
6	Capacity (dry solids)	10	tph
7	Filter cake moisture	20.0%	w/w
8	Moisture after dryer	2.0%	w/w
10	Wet cake	12.5	tph
11	Moisture evaporated	2.3	tph
16	Cake moisture	15.0%	w/w
18	dry solids	14.7	tph
19	wet cake	17.3	tph
20	Moisture evaporated	2.3	tph
22	Increase	47.1%	
23	Increase	4.7	tph

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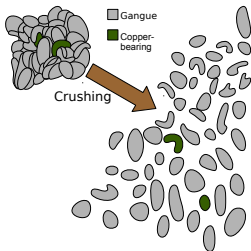
└ Outcomes – what do they mean?

└ Equally

Equally
Support you are limited by evaporative capacity

But a challenge

Ever finer grind-size.



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└ Outcomes – what do they mean?

└ But a challenge

But a challenge

Ever finer grind-size



So how to make the best of this?

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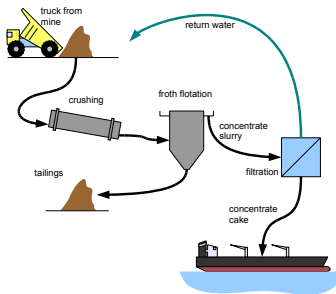
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└ Outcomes – what do they mean?

└ So how to make the best of this?

So how to make the best of this?



Example – drum filtration

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└ Example – drum filtration

Example – drum filtration



Example – drum filtration

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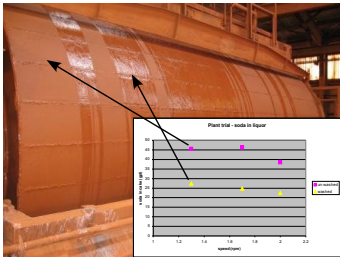
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└ Example – drum filtration

Example – drum filtration



Suppose you have 3 drum filters

What would be a sensible way to operate?

- Two duty, one standby, or ...

Vacuum drum filter scenarios

Number of units	speed (rpm)	cake thickness (mm)
1	8	5
2	2	10
3	0.9	15



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The effect of speed on filtration throughput (rotary drum filter)

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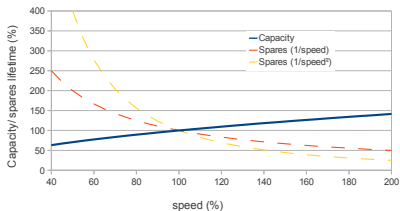
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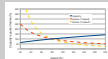
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The effect of speed on filtration throughput (rotary drum filter)

The effect of speed on filtration throughput (rotary drum filter)



It is well-known that the throughput of a drum filter should vary with the square-root of the speed. In other words, if you double the speed of a drum filter, then the theoretical maximum benefit is an increase in throughput of around 40%. However, let's assume that the cloth lifetime is determined by the number of rotations (and therefore the number of times that the cake is peeled or scraped away from the filter cloth).

In multi-filter applications, it may not be wise to keep-back a number of filters, while turning the remaining filters as fast as they will go.

Conclusions

- What should the filter engineer know?
 - You can be scientific in your approach (postulate an idea, form a disprovable hypothesis and experiment) without, necessarily, being overly calculating.
 - There is a great deal of information out there.
 - Probably a bit more than they currently get.
- How the outcome of your filtration process affects the success of the overall process, if possible quantitatively.
- How crucial filter-media are to all of this.



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