PLANT DESIGN CONSIDERATIONS

Mark Vancas (Bateman Litwin)

The Power Point presentation which accompanied the keynote paper on Plant Design Considerations is shown following this section. Following the presentation, the following points were discussed:

- The design is often based on a flux ratio of $5m^3/m^2/sec$.
- The general "rule of thumb" in the design (e.g. Cu) for the linear velocity is 3 cm/sec.
- In the case of the Bulong Nickel plant (and several other operations), deep settler tests were used to obtain the design.
- Measurement of the amount of entrainment will assist in the design.
- As regards materials of construction, FRP and metals have been used for most construction, while PVC on occasion for internals.
- The static electricity criteria is < 1 m/sec into the tank, while Shell state <7 m/sec. Dissipation of the charge will occur through proper grounding and allowing sufficient time in the organic tank.
- Mists are generated, in part, by the overflow (and drop) into the launder.
- As regards the use of stainless steel in construction, grades have included 316 (or better), 2507, 225 etc.
- Mixer settlers within buildings are covered and vented to atmosphere.
- For safety purposes in the case of a fire, the design is for the organic to be discharged from all settlers to external ponds. The discharge in a short time from very large settlers could be a problem.
- Large settlers of 30 m x 30 m are covered by a roof.
- For fire control, foam and sprays can be used. Some foams (Triple F seems the best) do not adversely affect the solvent extraction process, but the foam has to first be removed by washing prior to running the SX circuit.
- Between circuits there should be a distance of 6 m space to isolate in case of fire.
- In the discharge from the settlers, only the organic phase should be discharge, in full lines.
- Linear velocity and flux are important in the design—an increase in these parameters results in a decrease in performance.
- A shallow dispersion band width results in higher entrainment.
- Picket fences decrease the linear velocity, and the positioning of the fences will be dictated by the particular system.

- The Holmes & Narver settler design, in which there were vertical baffles to slow the linear velocity, were probably a good design and perhaps this “old” design should be again considered.

- There should be an increased focus on the mixer in order to decrease the high shear and therefore the extremely small droplets that are produced. The pumping should be separate from the mixing.

- In-line mixers should be considered.

- Perhaps a shaft containing 2 impellors should be considered in the design.

- In Cu circuits, the arbitrary mix time is 2-3 minutes in extraction and 2 minutes for stripping.

- Also in Cu extraction, at ratios in the mixer box of 1:1 and 2:1 A:O, kinetic tests have been performed in which the mixing was varied over the range of 100-1000 rpm in a rectangular box. In extraction, the extraction efficiency increased with increase in rpm.

- Discussion on the phase ratio that should be maintained in the mixer indicated a range of about 1:1 to 2:1

- In some mixers in Chile a straight blade was changed to a curved impellor and the latter showed improved reduction on solvent losses. At Chino (Phelps Dodge) there was no reduction noted with the change, but that may be due to increased flows at Chino.

- Lightnin mixers appear easier to maintain compared to the Spirox of Outokumpu which require a plant shut-down for maintenance.

- There was a good discussion on the possible use of in-line mixers and a power point presentation amplified that discussion. There appeared to be good agreement on the positive aspects of the in-line mixers to replace the conventional high shear mixers.

- In addition to the use of in-line mixers to provide mass transfer, it was noted that they have been successfully used in plant operation for the mixing (pre-equilibration of DEHPA) with ammonia in the extraction of Co and separation from Ni process.

- As regards to circuit configuration, most of the variations have been implemented in Cu operations. The circuits were originally designed as series, and subsequently many plants incorporated series-parallel configurations. Prediction of design has been by computer programs. By making a change to series-parallel there is a decrease in capital costs but an increase in operating costs. Such a design may provide some additional flexibility. Multiple trains have been designed. The design was originally used for dump leach operations.

- With increasing restrictions imposed by insurance companies, the design and development of a plant has become increasingly more difficult.

Gordon Ritcey SX Workshop 2007

Plant Design Considerations

Presented by:
Mark F. Vancas

Plant Design Considerations

Design Criteria

- Production Rate
- PLS Grade
- PLS Flowrate

Plant Design Considerations

Design Criteria

- Mixing times
- Flux Rates
- Velocities
- Advance Ratios
- Mixing Ratios
- Phase Depths
- Maximum Organic Loading
- Maximum Organic Transfer
- Cu/Fe Selectivity
- Organic Entrainment in Aqueous

Plant Design Considerations

Design Criteria

- Aqueous Entrainment in Organic
- Circuit Configuration
- Number of Mixing Stages
- Impeller Types and Tip Speeds
- Materials of Construction
- Static Electricity Reduction and/or Elimination
- Fire Protection

Plant Design Considerations

Other Considerations

- Crud
- Operability
- Maintenance
- Client Desires
- Niceties and Necessities
- Client Knowledge
- Operating staff knowledge & capabilities
- Location and Plant Layout
- Piping Design particularly around Pump-Mixers
- Level of Automation
- Cross contamination of series circuits

PLANT SETTLER COMMISSIONING

Mark Vancas (Bateman Litwin)

The Power Point presentation which accompanied the keynote paper on the Plant Settler Commissioning is shown following this section. Following the presentation, the following points were discussed:

On start-up:

1) Fill the circuit with water and test for leaks throughout the system.

2) Bleed in the PLS.

3) Add copper sulphate to the strip circuit to provide the electrolyte.

4) Add diluent.

5) Extractant is added to the launder to the loaded organic tank.

6) Control of the plant:
   - i) flowmeters types: ultrasonic, pressure, orifice meters and others
   - ii) phase continuity, measure by conductivity in the mixer. If the phases invert (flip) then the situation can be returned to the desired phase continuity by shutting off the flow of one phase for a few minutes.
   - iii) O/A ratios
   - iv) pH – operator control in some plants; control room in others. Control is best obtained by scheduled sampling so there is a “walk-around” to check the plant at the same time.
   - v) phase separation times – tests should be performed each shift, and certainly at least daily.
   - vi) Loading tests – daily and more frequent depending upon PLS tenor, flow control, etc. Low loading does not necessarily indicate reagent degradation, but possible solvent fouling.

7) Analysis for control – every couple of hours

8) A set of “standard samples” often can be useful to visually monitor the circuit.

9) Shut-down – often when one mixer shuts down, all mixers are shut down

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Presented By

Mark F. Vancas
BSX Process Specialist

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Piedras Verdes

Mantos de la Luna

Basic Criteria

Plant	Mantos de la Luna	Piedras Verdes
Location	Tocopilla, Chile	Alamos, Sonora, Mexico
Rated Production	25,000 t/a	32,000 t/a
Leach Material and Method	Crushed, Agglomerated Ore on a dynamic Pad	ROM ore on permanent pad of approximately 100 m ultimate height
Leaching Media	Acidified Sea Water	Acidified Potable Water
Materials of Construction	FRP, HDPE	Stainless Steel
PLS Grade	4.2 g/l design, 3 g/l at present	3.1 g/l design, 2 g/l at present
PLS Flowrate	750 m^3/h, 700 m^3/h at present	1350 m^3/h design, 2000 m^3/h at present
Design Unit Flowrate	3.66 $m^3/h/m^2$	5 $m^3/h/m^2$
Circuit Configuration	2 extract, 1 wash, 2 strip	2 extract, 1 strip
Control Philosophy	Fully automatic	Manual

Let's now go on a photographic tour of both sites.

In the process we will:

Look at some Client/site specific details

Discuss some of the Lessons Learned

Have some fun, and

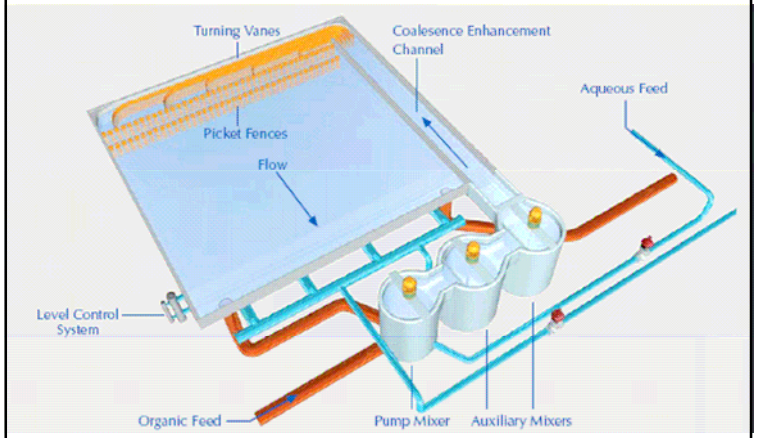
Hopefully generate some discussion

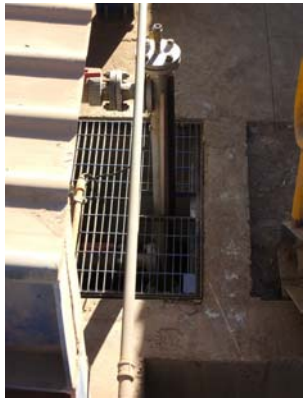
MDL uses pumped PLS feed

PV uses gravity flow of PLS

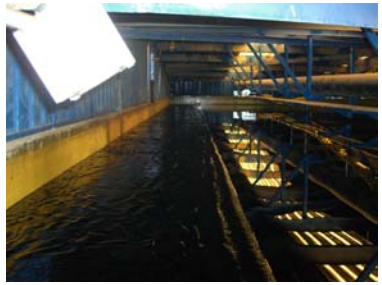
Mantos de la Luna

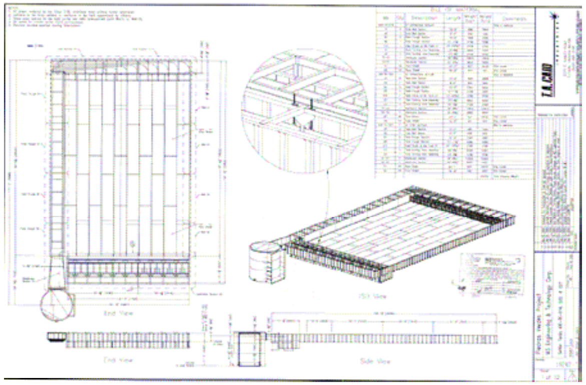
The settlers for MDL can be called the genuine **BATEMAN SETTLER®**



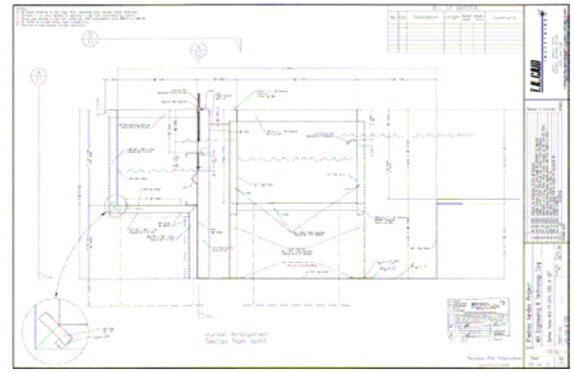


MDL control circuit includes interface and organic advance controls



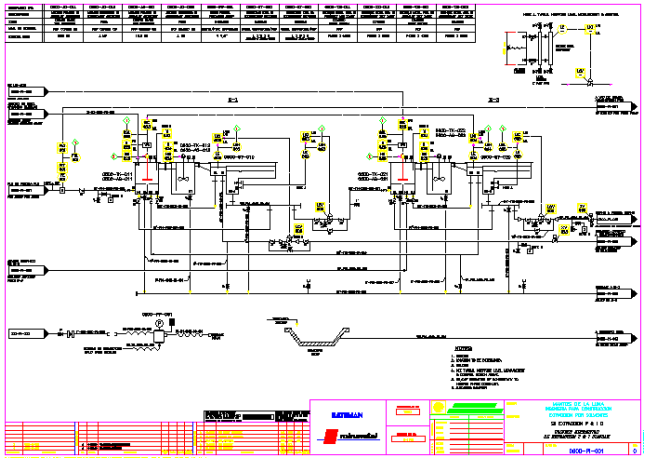


PV on the other hand uses traditional organic and aqueous discharge weirs however I did insist on retaining the submerged aqueous launder.

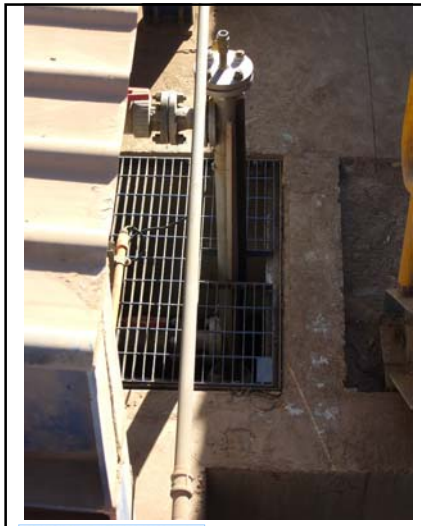


MDL has automatic valves in many locations including bypasses and manual valves

Mantos de la Luna was the first fully automatic BATEMAN SETTLER® installation.

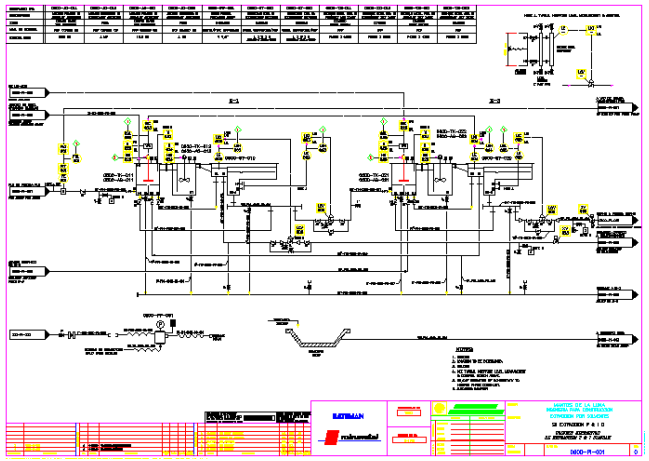


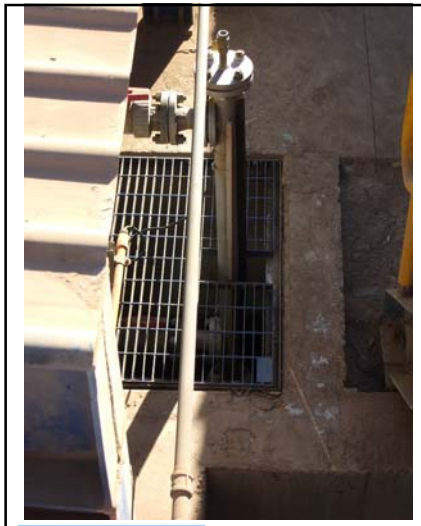
This is what I consider perfect launder control, but it was not this way at the start.



Control of the interface in the settlers was problematic initially.

Fluctuations in organic flow were compounded by instrumentation that was not installed correctly.





Control of the interface in the settlers was problematic initially.

Fluctuations in organic flow were compounded by instrumentation that was not installed correctly.

Solenoid valves were installed to avoid reagent loss in case of an automatic valve failure during shut down but, inappropriately applied, thin walled pipe collapsed under vacuum.

What about performance of this automatic system?

Entrainment of organic in the raffinate is generally lower than 30 ppm and entrainment of aqueous in the loaded organic has consistently been less than 100 ppm.

This is particularly beneficial because the leach solution is sea water at more than 20,000 ppm Cl but yet the Cl levels in the electrolyte are approximately 15 ppm and pose no danger to the stainless steel cathodes used in EW.

The biggest headache at PV was getting the pump-mixer impellers set within specifications of the false bottoms in the primary mixers.

To date the impellers have been able to move 4000 m3/h of combined flow with impeller speeds of 95% of maximum and the organic advance valves less than 100% open.

Piedras Verdes has a fire fighting foam system that was tested before the diluent was introduced to the circuit.

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To avoid agitation and air entrainment as much as possible gravity lines into tanks were piped such that the discharge was below the surface.

In the electrolyte tanks we outsmarted ourselves. We turned down the inlet but we also turned down the overflow so as to stop organic (if present) from flowing from one tank to the other.

Well, we turned down the other end of the overflow as also and in doing so created a siphon.

We tried to reduce capital costs by using gaskets of EPDM surrounded by a teflon envelope.

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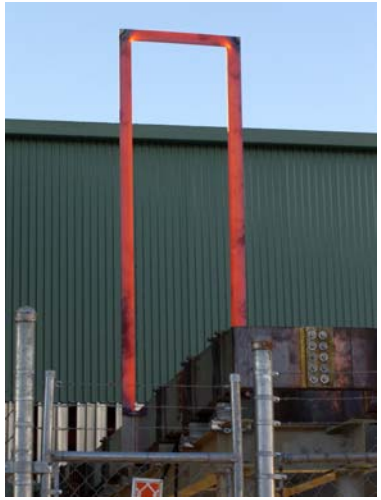

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Commissioning is where one sees the good and bad features of a particular design.

Commissioning is where one learns how to improve plant design.

For me, commissioning is the most exciting time of a project.