LIGHTNIN
EXTRACTION news

A Newsletter for Solvent Extraction Engineers | August 1995, Vol. 1, No. 3

Video Helps Optimize Pumper Designs

A new LIGHTNIN video imaging technique that analyzes droplet sizes and distributions can help determine pumper designs that minimize entrainment losses.

In a test tank, a video camera is focused on a small volume at the pumper outlet and captures droplets as they are generated by the pumper before any coalescence develops. The image is captured on a VCR and sent to a computer data acquisition system so data can be processed on-line or later from tapes.

A LIGHTNIN-designed computer program captures the ,e of the frame analysis, the number of droplets, and their X and Y coordinates. This procedure is repeated until approximately 1,000 droplets are counted to provide a statistically significant amount of data.

A separate computer program collects the database in formation, and categorizes the droplets in bin sizes determined by pixel resolution. This program determines the droplet distribution and other important statistical information such as the droplet diameter, area, volume, skewness, kurtosis, sample mean, mode and the Sauter mean diameter, d32.

Many types of mixers have been compared based on their drop mean diameter. Data shows this diameter as a function of tip speed for a variety of impeller designs. For a given tip speed, straight-blade impellers had the lowest mean droplet size and the LIGHTNIN R320 outperformed the others.

Recently, a customer compared a LIGHTNIN curve-blade R321 and straight-blade R301 on parallel trains in their SX plant. Both pumper diameters were greater than 2.1 meters. Over a three-month period, the curve-blade R321 halved the organic and aqueous entrainment losses of the R301.

By studying droplet distributions, LIGHTNIN has found a way to predict entrainment losses and, more importantly, reduce them by redesigning the pumper impeller to have an optimum shape.

When it Comes to Saving Money, It's All in the Droplet Size

By studying more than 200 pumper designs and configurations, LIGHTNIN has proved a distinct link between droplet size and entrainment losses, which often is the second- or third-highest cost of a solvent extraction plant.

Per volume, small droplets have larger surface areas than large droplets. This is important for mass transfer; however, excessive shear and turbulence can make these droplets too small, which causes aqueous components to be trapped in the organic phase, and organic components to be trapped in the aqueous phase. Organic traces in the electrolyte impairs the quality of the electro-deposited copper; organic traces in the

Continued on page 5

Follow Basic Rules for Portable Mixers To Ensure Success and Achieve Results – Guaranteed

No matter the size of the job, considerable engineering and technology are required to achieve proper mixing results. That's why the same amount of attention needs to be paid to smaller applications that use portable (smaller horsepower) mixers as those using large mixers.

Some typical applications where portable mixers are used are electrowinning addition, clay, organic sidestream, cobalt, ferrous sulfite, organic treatment, and reagent preparation.

Because improper installation can lead to excess swirl and vortex, increased blend times, settled solids, and the need for additional equipment such as pumps or airlines, basic rules need to be followed to ensure successful mixing.

Your process determines the tank and the mixer. It also determines the best positioning for your mixer on the tank. In fact, performance results depend as much on correct mounting as they do on specifying the right mixer to begin with.

If you have no restrictions on tank geometry, the optimum shape is cylindrical with the liquid level between one and one-and-a-half times the diameter of the tank. But don't hesitate to use any shape tank you already have or whatever shape your floor space might dictate.

It's the job of your LIGHTNIN representative to specify the size and design of the mixer, shaft lengths, and impeller(s) you need to fit your tank. As always, we guarantee the results.

If you change the tank or process, here are some guidelines:

- Impeller location should be at least one impeller diameter from the bottom of the tank.
- Where more than one impeller is used, the spacing between them should be at least two impeller diameters for gear drive mixers and least four impeller diameters for direct drive mixers.
- Call your nearby LIGHTNIN office. Even if you've owned your mixer for many years, consultation on new applications is free. Often, a change in impeller or accessories at nominal cost can make your mixer more effi cient in its new assignment and prevent unwanted overloads or process upsets.

POSITIONING YOUR PORTABLE MIXER

- ***Angular off-center*** – Aiming the shaft off-center avoids vortexing and the need for tank baffles. It achieves strong top-to-bottom turnover and is optimal for most mixing and blending.

- ***Centered*** – Vertical on-center mounting creates vortexing in an unbaffled tank. While undesirable for most work, vortexing is required to draw down light liquids and hard-to-wet powders.

- ***Repositioning during the batch*** – Sometimes, more than one kind of mixing action is needed. For example, you may first need to dissolve light powders. To do this, the mixer is mounted on-center to create a vortex that quickly draws down the powders and disperses them into the batch. Then, to maintain a uniform suspension, or to blend other fluids, you reposition the mixer to angular off-center. Clamp-mount portables make the repositioning easy.

- ***Tank baffles*** – If you center-mount a mixer, you can avoid vortexing by adding four vertical baffles equidistant around the inside edge of the tank. Generally, baffle width should be 1/12th the diameter of the tank. As viscosity of the batch increased (Reynolds number decreases), the need for baffles decreases because of the self-baffling effect of more viscous material.

Considerations for Selecting an Impeller

By Dr. Tom Post

The function of any mixing impeller is to achieve the desired process result by dissipating energy in a combination of flow and shear. A full spectrum of mixing impellers is available to meet the needs of applications ranging from those that require high flow at minimum shear (head) to those that require high shear (head) and little or no flow.

The optimum impeller design depends on the process's requirement for flow and shear.

Performance categories

Impellers fall into three categories of impellers based on their performance: flow, shear and pressure. While each impeller has a primary function, such as developing flow, it always has components of the other functions (shear and pressure) that must be considered for design.

The majority of processing requirements are flow-controlled applications in which the flow generated has a direct result on the outcome of the process. These applications require good contacting and top-to-bottom motion throughout the vessel to maintain good solids suspension and blending.

Example: A blending application that involves mixing two immiscible phases requires high bulk fluid flow to ensure good contacting while generating very little shear that could emulsify the two components of the mix.

The second category of impellers produce high shear–a high level of energy in a small area. This is done for applications ranging from pigment dispersions and solids makedown to gas dispersion and emulsification.

Example: A paint makedown application in which solid pigments are drawn into the liquid paint and dispersed requires very high energy input in the form of a dispersing impeller to ensure a good pigment concentration and particle size across the whole batch. The dispersing impeller produces very little flow, while imparting extremely high amounts of localized shear to break down and disperse the solids uniformly in the liquid.

The third category of impellers is those that push against a static head or pressure. These impellers are able to overcome start-up and continuous operating head differentials while producing the flow necessary to complete the process.

These impellers are used in various applications, but most notably in minerals processing circulators (CIP tanks, alumina precipitators, and phosphoric acid isothermal reactors).

Pumping capacity and power draw

Each category of impeller has unique flow, head and power response characteristics. This information can be used to

Flow **Shear**

A6000 Highest Flow Composite Impeller

Offers very low shear and higher flow than any other impeller. You can maintain flow and reduce power 50-60%, or maintain power and increase flow up to 200% compared with pitch-blade turbines.

A410 Composite Impeller for Portables

Handles a broad range of viscosities under a wide variety of process conditions. Provides 50% more flow than conventional three-bladed, marine-type props.

A310 Highest Flow Metal Impeller

Considered the most efficient metal impeller available, this laser-designed impeller redefined flow performance for the industry.

A200 Classic Pitched Blade Impeller

Lightnin's classic 45° pitched blade impeller produces a desirable balance of flow and shear, making it the impeller of choice for hundreds of standard applications.

R100 High Shear Impeller

Provides the shear to achieve good contacting for liquid-liquid dispersions and emulsions. Also used to provide high shear for gas dispersions.

Relative flow efficiency (shown below) defines the flow-per-unit-horsepower delivered by a specific impeller type and can be used in determining the relative flow efficiency of different impeller types.

43.657	*35.828*	*31.547*	*13.224*	*2.9826*

calculate an individual impeller power draw and primary flow generation as well as comparing the performance on one impeller to another. One such correlation is the "flow efficiency" of a particular impeller. This is a representative number that defines the flow-per-unit-horsepower delivered by a specific impeller type and can be used in determining the relative flow efficiency of several different impeller types.

Because power consumption is the most measurable and significant capital cost factor, it determines the selection of the mixing impeller. For example, paint dispersions are done with relatively small diameter, high-shear, high-speed, low-torque, low-cost impellers. This same process could be accomplished using a high-efficiency impeller, but would waste considerable energy to achieve the same shear rate and power dissipation with an impeller designed for maximum shear and minimum flow. The converse also is true where a high-speed disperser could not operate in an efficient manner to blend a product storage tank that is easily mixed by the high-efficient impeller.

Conclusion

The best impeller for any given application balances the flow and shear required for a successful process with maximum efficiency. While most impellers can do an adequate job in any mixing application, the key is to select the impeller that is most efficient to the specific application.

Pressure/Head

R320 Pumper Impeller

Maximizes head and flow while reducing air entrainment through lower power consumption. Has lower shear generation and turbulence and greatly decreases operational expenses.

R300 Pumper Impeller

Straight-blade pumper turbine was the standard of the solvent extraction industry since the 1960's.

1.213 *1.0*

Computer Sizing Model Ensures Impeller Fit, Performance

Proprietary computer sizing software developed by LIGHTNIN is a convenient, accurate tool that uses laboratory data to ensure your impeller is right for the job.

When designing new plants, your LIGHTNIN representative can use the computer sizing model to easily check multiple configurations and provide results instantly. The database includes more than 150 different impellers and allows plant optimization.

For retrofits, LIGHTNIN can develop a profile of your existing operation from a database of impellers and compare it to actual plant data. We can then optimize power consumption and shear generation and minimize entrainment losses, while maintaining plant throughput by using our R320 pumper impeller.

The computer program graphically shows head vs. flow, power vs. flow, hydraulic efficiency vs. head, and hydraulic efficiency vs. flow.

To make sure your impeller is sized right for the job, contact your LIGHTNIN representative.

For additional product or application information, call your local LIGHTNIN sales engineer, located in principal cities around the world. In the United States, call toll-free, 1-800-320-3526, ext. 633, for the name and phone number of the LIGHTNIN representative in your area.

Questions or comments for the LIGHTNIN Extraction News should be forwarded to:
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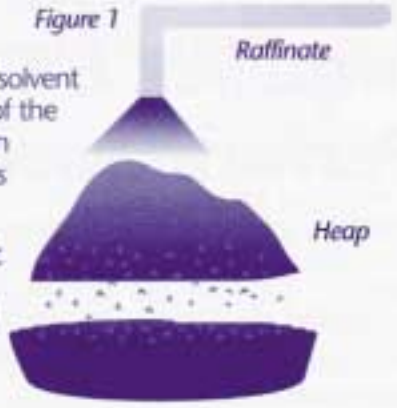
Steps in a Solvent Extraction Process

Figure 1



Key to the success of solvent extraction is the size of the droplets created when two immiscible liquids are mixed.

One liquid is a sulfuric acid solution that is sprayed on a mineral heap (**Fig. 1**). After trickling through a heap of crushed ore, the pregnant leach solution (PLS) is laden with copper and many other minerals (because the extraction with sulfuric acid solutions is not selective). To extract just copper, which is key to making the process viable, the PLS must be brought into contact with another fluid that latches exclusively onto the copper.

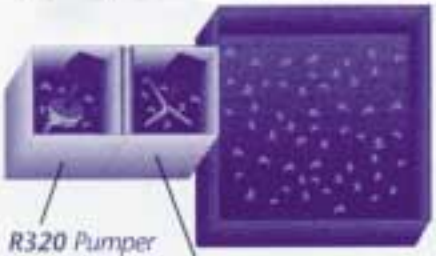
That extractant is an organic chelating agent diluted with a relatively inexpensive carrier or diluent such as kerosene to maintain the proper concentration.

Because the acidic PLS and the kerosene/extractant are immiscible, the two fluids must be mixed vigorously to form a dispersion of droplets (**Fig. 2**). During the contact phase in the primary and auxiliary tanks, the copper transfers from the acidic aqueous phase to the organic phase and is anchored to the chelating agent. The two phases separate in the settling tank.

To be deposited at the electrowinning house, the copper must be stripped from the organic and returned to a conductive aqueous phase (**Fig. 3**). Mixing must generate uniform-size droplets to optimize the interfacial area between the spent electrolyte and the copper-laden organic phase, improve mass transfer and allow reasonably fast separation of phases.

The aqueous phase can then go to the electrowinning cells and the organic returns to service extracting copper from the PLS.

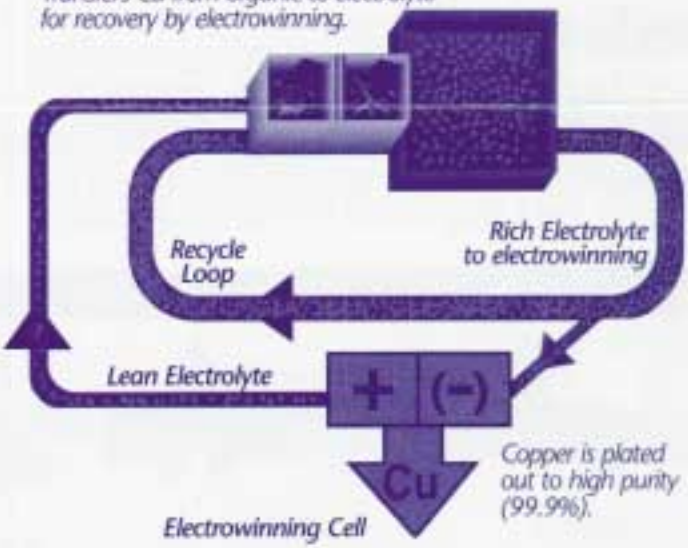
Figure 2. First Stage Extractor
Transfers most of the Cu from the aqueous phase to the organic phase.



***R320** Pumper impeller for proper head, flow and hydraulic efficiency.*

***A310/A6000** Auxiliary impeller for good contacting. Prevents excessive shearing.*

Figure 3. Stripper
Transfers Cu from organic to electrolyte for recovery by electrowinning.



Saving Money...

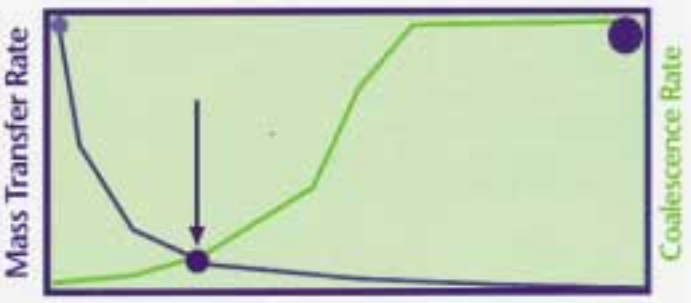
Continued from page 1.

raffinate are sent back to the heap and are lost to the environment. In either case, these losses must be recovered or replenished.

Droplets that are too big are not as efficient because the surface area-to-volume ratio decreases with the increasing droplet size and therefore causes incomplete mass transfer.

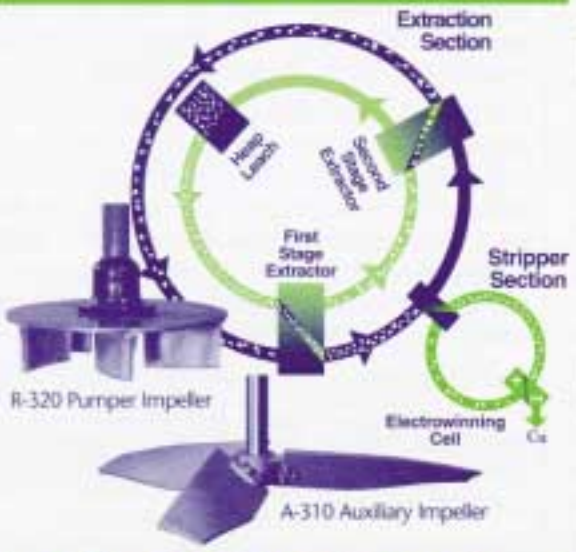
LIGHTNIN's R320 pumper impeller and A310 high-efficiency auxiliary impeller assures the proper droplet size required for good mass transfer/extraction and minimum entrainment.

Optimum Droplet Size For Mixers-Settlers



Look for our solvent extraction ad in the July 12 *Mining Record* and the July issue of *Engineering and Mining Journal.*

Make the most of your solvent extraction system.



Call 1-800-320-3526 ext. 633

The new LIGHTNIN Solvent Extraction System can substantially increase your copper extraction productivity while eliminating the excessive shear and air entrainment common to the high power levels you need to meet production demands. Best of all, high-efficiency impeller designs let you improve your current system without redesigning your plant.

With the LIGHTNIN Solvent Extraction System, you'll:

- Increase efficiency for higher performance;
- Minimize entrainment losses;
- Improve mass transfer;
- Reduce gearbox size, installed horsepower, energy costs, and wetted material cost (especially in high alloy);
- Maintain a steady copper cathode production rate as the Pregnant Leach Solution grade fluctuates.

Guaranteed Results

Working together, you and LIGHTNIN determine how mixing can optimize your solvent extraction process. Then we guarantee the results.

LIGHTNIN

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