Webinar *Density Measurement in Slurry Pipeline Flows* - Q&A

Answers provided by Dr. Ryan Spelay from the Saskatchewan Research Council (SRC).

Please contact SRC at pipeflow@src.sk.ca for more information.

Audience Question	SRC Answer
Do you have models for sanding detection in a tailings pipeline?	Yes, the SRC PipeFlow Models (10.2, M1.0) provide predictions of the deposition velocity (sanding) for the turbulent pipe flow of settling slurries. SRC also has a number of instruments capable of providing measurements of the deposition velocity (bed detection) or the point at which a stationary bed forms in a slurry pipeline flow. The SRC PipeFlow models are provided at the SRC Slurry Pipeline Courses. Our next course is May 16-19, 2023, in Saskatoon, SK. Please contact pipeflow@src.sk.ca or go to www.src.sk.ca/pipeflow for more information.
How do you achieve back pressure in a pipe for a Coriolis density measurement?	To function properly, most Coriolis flowmeters must be installed in a location where there is sufficient back pressure (e.g., at the discharge of a pump) or sufficiently upstream from the discharge of a pipeline to atmosphere. The installation location is important. If this is not possible, a throttling valve or flow restriction can be used to create back pressure.

What´s your take on the Endress+Hauser density liquiphant FML621?	This instrument is a tank-level measurement device. I am unfamiliar with it so I cannot provide any comments on its applicability to slurry flows. Saying that, we perform slurry pipeline testing at our Pipe Flow Technology Centre and can test the performance of different instruments for multiphase mixtures under a wide range of operating conditions. This includes testing them against other instruments or standards.
Is coarser particle sedimentation an issue for solids concentration measurements on vertical piping?	In vertical flow, if the velocity is low and there is enough breadth in the particle size distribution, the coarser solids (more slip) will move slower relative to the finer solids. This results in axial segregation or herding. This can result in flow instabilities, making solids concentration measurements more difficult.
I've seen some early testing of an "Ultimo" device on the same line as a gamma gauge – the signal was a little noisier, but appeared to track well. Do you have any comments on this or other more recent or evolving non-radiometric instruments for in-plant settling slurry pipelines?	I am not very familiar with the "Ultimo" technology. We have never tested this device at SRC. From what I have read, it uses a percussion/vibration-based technology and then analyzes oscillations to determine the density of the slurry in the pipe. It may be sensitive to vibrations. We perform slurry pipeline testing at our Pipe Flow Technology Centre and can test the performance of different instruments for multiphase mixtures under a wide range of operating conditions. This includes testing them against other instruments or standards. We would be able to test this device against a gamma-ray densitometer if this is of interest.

What precautions need to be made when conducting maintenance on GRT to prevent exposures to workers?	The GRT and other gamma-ray technologies are fairly maintenance free. Procedural safety protocols, as well as some engineering controls, are used to protect workers from ionizing gamma radiation when using the instrument. 1. The sources are shielded in lead or steel to reduce exposure when working near the instrument. Release is through an aperture, so the ionizing radiation is directional (out the front through a shutter). 2. The radiation beam is collimated to contain the width of the spread. This is sized so the beam is only focused on the detector. 3. All users are trained in the proper handling and use of the sources. 4. The ALARA (As Low As Reasonably Achievable) principle is followed. Exposure is limited through time, distance and shielding. 5. All operators wear a dosimeter to track their exposure. 6. Operators always work behind the source away from the path of the beam (where there is very little exposure). 7. The unit is installed where there is limited traffic. Operators do not work in the area around the instrument. 8. Appropriate signage is used to warn people regarding the danger of gamma-ray radiation in the area. 9. Licensing and regulation is strict and requires leak testing and annual inspections from the Canadian Nuclear Safety Commission (CNSC).
Is SRC able to develop novel instrumentation from concept to prototype to commercial design and fabrication?	Yes, SRC has developed novel instrumentation and technology to help industry/operators solve various operational or technical problems. Depending on the technology to be developed, there are many groups at SRC with different areas of expertise that can be brought in to help on a project. Contact us if you'd like to discuss working together: pipeflow@src.sk.ca.

Is there a rule-of-thumb for a particle diameter cutoff between fine and coarse particles?	For silica sand and clay-based slurries (ρ_s=2650 kg/m^3), the typical cutoff used to separate coarse sand from fines is 45 µm. For the most part, this is a practical separation limit that distinguishes coarse settling solids (> 45 µm) from flocculating, non-settling fines (< 45 µm). For other industries with particles densities > 2650 kg/m^3 the cutoff can be much finer (i.e., iron ore) where a value closer to 20 µm may be more appropriate.
How do you control the stream sampler velocity in an Isokinetic meter?	The flowrate (velocity) through the sampler is typically controlled by using a throttling valve and a flowmeter on the sample stream being removed from the pipeline. The valve is adjusted so that the velocity in the pipe (V) matches the velocity in the stream (v). A full discharge sample (or other representative sample) is then withdrawn from the sample stream when the conditions are steady.
What is your opinion on Vezin samplers? It is installed in linear metallurgical sampler system. **Is vertical or horizontal installation more advantageous for density measurement?**	I have never used a Vezin sampler before, but we have used a similar technology to representatively split larger samples into smaller subsamples (a rotary riffler). As long as the slurry is consistent and the solids PSD of the slurry is not too broad, the unit has proven to work well. If you are interested in us testing the performance of the Vezin sampler for your specific application, email pipeflow@src.sk.ca and we can arrange a time to discuss this in more detail. It all depends on what you are interested in measuring. For a homogeneous slurry, either horizontal or vertical orientation will provide the same result. For a heterogeneous settling slurry, the most representative measurement will be taken from a pipeline operating with a uniform solids concentration. This means taking the measurement at the pump discharge or in a vertical section of pipe is

	advantageous as the solids are well distributed with uniform solids concentrations. In horizontal flow, for settling slurries, the solids concentration profile is segregated with a higher solids concentration at the bottom of the pipe and a lower solids concentration at the top of the pipe. Care must be taken to ensure that the measured density is representative of the entire pipe cross-section and not skewed by the variation in the solids concentration across the pipe diameter.
Are your PipeFlow Models available online?	The SRC PipeFlow Models are provided at the SRC Slurry Pipeline Courses. Our next SRC Slurry Pipeline Systems Course is May 16-19, 2023, in Saskatoon, SK. Please contact pipeflow@src.sk.ca or go to www.src.sk.ca/pipeflow for more information. The single species SRC PipeFlow 10.2 model is provided at our Slurry Pipeline Systems Course. It is an Excel-based model. We also have recently released an advanced multispecies model (SRC PipeFlow M1.0), which handles slurries with broad-size distributions (multiple coarse particle species), carrier fluids with yield stresses and inclined pipe flows. This is a web-based model and requires completion of the SRC Multi-Species Model Course. We are currently developing advanced models for the laminar flow of settling slurries with yield stresses and for flows of settling slurries with stationary beds (3-Layer model). These models are still in development.

Do you have any datasets you can share comparing the result of your gamma tomography with one of the electrical reconstructions?	Most of the data sets we have with these instruments are confidential. However, we have published a paper with some GRT vs ERT comparison results for industrial slurries. If you would like a copy of this paper, please contact pipeflow@src.sk.ca and we can send it to you. Reference: Hashemi, S.A., Spelay, R.B., Sanders, R.S., Hjertaker, B.T., "A Novel Method to Improve Electrical Resistance Tomography Measurements on Slurries Containing Clays", Flow Measurement & Instrumentation, 80, (2021), 101973
Would wood fibre-type flows (pulp and paper applications) fit within your presentation (industrial slurry) or does this require a different approach?	We have tested pulp and paper slurries at SRC in the past. As mentioned, these would likely be industrial slurries. Most of the existing technologies used to measure slurry densities are applicable to pulp and paper slurries. There may be some special considerations with these slurries (i.e., pulp or wood fibre particles would float rather than settle). If you are interested in testing a specific instrument or technology related to pulp and paper slurries, we can perform slurry pipeline testing at our Pipe Flow Technology Centre. Please contact us at pipeflow@src.sk.ca.