numcore

INSIGHT INTO SOLUTIONS

INSIGHT INTO SOLUTIONS TECHNOLOGY

3D VOLUMETRIC MACHINE VISION

Have you often wanted to see inside your process pipes and vessels and know what is really happening? Would you like to optimize your process to save energy and costs, still increasing the yield with better quality?

Numcore Ltd is a company that develops and markets innovative monitoring and control systems which are based on tomographic technology for on-line use in process industry. Numcore was founded in December 2007 in Kuopio, Finland. Numcore merges the experience and knowledge from academic and engineering worlds. The founders are leading experts in various fields of process industry, research and development.

The CoreApus, CoreTucane and CoreHydra measurement systems are Numcore's solutions for process imaging and control. For the first time you can really see inside your process. Using innovative three-dimensional imaging technology, you can monitor the process on-line, enabling efficient and energy saving control of your process. Numcore products can be used in different fields of process industry, such as pulp & paper, mining, bioenergy, biofuel and food production.

The CoreApus, CoreTucane and CoreHydra systems are results of several years of research and pilot tests. These R&D efforts have convinced us that this technology can offer completely new possibilities for process monitoring and control.

TECHNOLOGY

There are numerous situations in different kinds of processes in mining, food processing or pulp and paper industries, for example, in which there is a need to investigate the properties of the mass flow in a pipeline or some container. The object of the investigation can be, for example, the distribution and size of bubbles in a liquid or the mixing of an additional substance supplied into the flow.

Electrical impedance tomography is an imaging modality in which electrical measurements are made by electrodes placed on the surface of, or within the target volume and the electrical conductivity distribution of the target is determined based on the measurements. Spatial variations in the conductivity that are revealed by impedance tomography indicate variations in the quality of the flowing mass and can thus give information for example about non-dissolved gas or other non-uniformities of the mass.

Compared to commonly used point measurements, tomographic imaging techniques are sensitive for the whole target volume. Therefore it catches all the variations, no matter where they are located in the target volume. Point measurements often miss valuable information due to the spatial insensitivity of the measurement procedure.

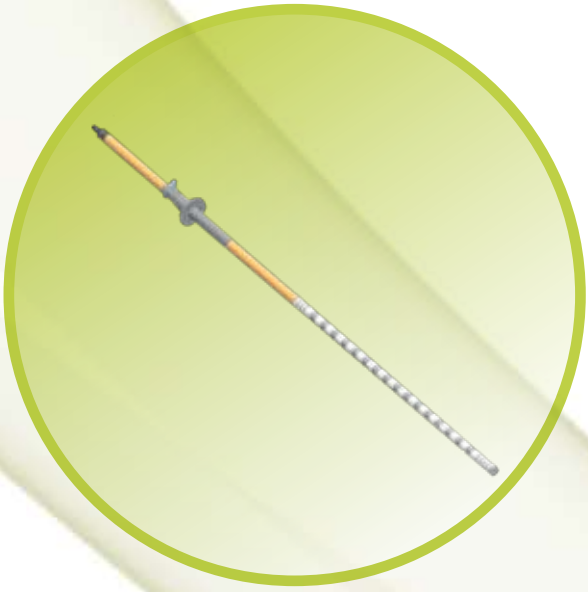

Fig. 1: **CoreHydra sensor.**

CoreHydra product family is a basic model of Numcore's tomographic sensors. The sensor is a probe-type sensor which can be installed inside tanks and vessels in which the flows are slow. It is available in 0.25 to 6 meter lengths, and with 16 to 32 measurement channels. The maximum frame rate is 20 frames per second. The frame rate can be increased using boosted electronics from CoreApus. The probe itself can be made of plastic or Teflon, reinforced with glass fiber or stainless steel core.

Fig. 2: **CoreApus sensor.**

CoreApus product family is the high end product of Numcore's tomographic sensors. The sensor is a flow-through sensor and it is mainly used for imaging mass flow inside pipes. It is available as one to five ring models with 16 to 64 measurement channels. In high velocity flows, the 5 ring model is needed and in slow (1-2 m/s) one ring model is an option. The sensor part can be made either of plastic or Teflon covered with high quality stainless steel. The maximum frame rate is up to 80 frames (images) per second.

The world leading product families of the tomographic sensors

The CoreApus *(Fig. 2)*, CoreHydra *(Fig. 1)* and CoreTucane *(Fig. 3)*. measurement systems comprise an electronic unit including the current injection and voltage measurement units, the sensor part including the measurement electrodes, and a computer for data analysis and process control. The systems can be extended to a maximum of 64 measurement channels and currents can be injected through several pairs of electrodes, enabling high accuracy in 3D images. The data is analyzed in a computer, producing 3D visualizations of the target volume as well as trend information on the air and solid contents. With one glimpse the operator can see the state of the process and if needed, can make changes to the process parameters. For more advanced analysis, the CoreApus, CoreHydra, CoreTucane can use multi-frequency protocols producing spectroscopic images which can yield even more accurate information of the target.

Fig. 3: **CoreTucane sensor.**

CoreTucane product family is one of the basic models of Numcore's tomographic sensors. The sensor resembles a hydrodynamic wing and can be mounted on the wall of process pipes or tanks. It is available in lengths of 0.1 to 2 meters and with 16 to 32 measurement channels. The maximum frame rate is 20 frames per second with basic electronics. The frame rate can be increased using boosted electronics from CoreApus.

Application example: Optimizing and controlling MD variations due to homogeneity variations in pulp flow

Machine direction variation may be due to imperfect storage tower, mixing tank or mass tank dilution processes. Numcore's tomographic sensors can be used to detect consistency variations which cause MD variations.

The consistency variations and homogeneity of mass flow can be detected by measuring the outflow of the storage tower, the mixing tank and the mass tank with the CoreApus sensor.
By measuring the dilution area of the storage tower, the mixing tank and the machine tank with CoreHydra or CoreTucane, the consistency variations can be detected.
Using the measured tomographic information the stock system and dilution process can be controlled and optimized.
(Fig. 4 and Fig. 5)

Features and Benefits

- More uniform retention and sheet formation
- Better MD and CD profiles
- Improved formation
- Reduced energy consumption
- Troubleshooting of process conditions

Application example: Control of three-dimensional homogeneity and mixing

The mixing process can be imaged in three dimensions using Numcore's product families. Using the wholly new information the mixing process can be optimized using Numcore's technology resulting in very homogenous sheet, better quality and improved runnability. *(Fig. 6)*

Features and Benefits

- Decreased chemical consumption
- Reduced energy consumption
- Determination of mixing efficiency
- Improved product quality
- Improved mixing homogeneity and efficiency
- Troubleshooting of process conditions

Application example: Three-dimensional gas monitoring and control

Even small amounts of gas can cause problems in processes or cause problems with many measurement devices. Since gas, such as non-dissolved air or carbon dioxide, is electrically non-conductive it can be detected with Numcore's tomographic imaging systems. Large amounts (> 5%) of air in process pipes can be detected easily and even small amounts (<0.2 %) be seen with high accuracy.
This is due to the tomographic imaging approach of Numcore which is sensitive in the whole target volume. *(Fig. 7)*

Features and Benefits

- Determination of air distribution in multiphase flows
- Online measurement
- Wide measurement range (0 – 10 % of air)
- Changes in bubble size distribution can be detected
- Troubleshooting of process conditions

Application example: Three-dimensional imaging and control of flotation processes

Numcore technology is also especially well suited to three-dimensional imaging of the flotation processes. For the first time, it is now possible to see inside the flotation cell. With the CoreApus and CoreHydra technologies you can see inside the froth, image the air bubble and bubble size distributions and measure the solid matter content. This new information can be used to control the process, for example, by adjusting the air, frother or feed flows. The real-time 3D imaging and process control has a direct impact on improving the runnability and the outcome of the process.

The CoreApus and CoreHydra systems can measure without disturbing the flotation process. Compared to the existing camera technologies, CoreApus and CoreHydra can see inside the process, regardless the material opacity and, furthermore, is not just imaging the surface layer of the froth. This is a significant improvement over the existing technologies. Flotation cells of up to 500 mm in diameter can be imaged with the CoreApus sensors. In larger flotation cells, CoreHydra sensors can be used.

CoreApus in pilot tests at GTK, Outokumpu

During the year 2009, the CoreApus technology was used to image a column flotation cell in the Mineral Processing Laboratory of the Geological Survey of Finland (GTK) in Outokumpu, Eastern Finland.

CoreApus technology is very useful in developing flotation for new and sometimes complicated ores. It is a completely new way of looking at the process in whole. The tomographic images yield new information on the time-dependent ore and air distributions in the flotation cell. This information can be used to predict the behavior of the flotation process, such as the collapse of the solid content in the froth bed. This is totally new and very useful information, not available before the CoreApus technology of Numcore. *(Fig. 8)*

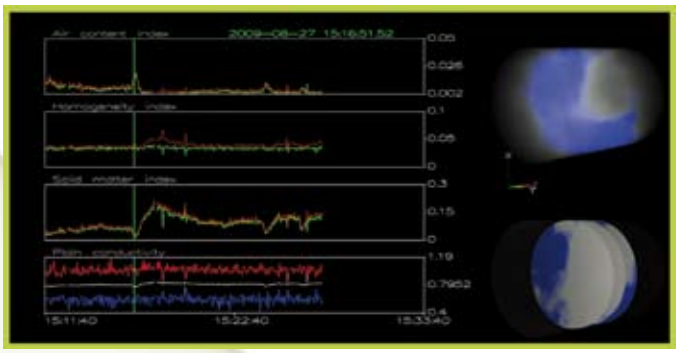

Fig. 4: **Air can be seen in the outflow of the storage tank.**

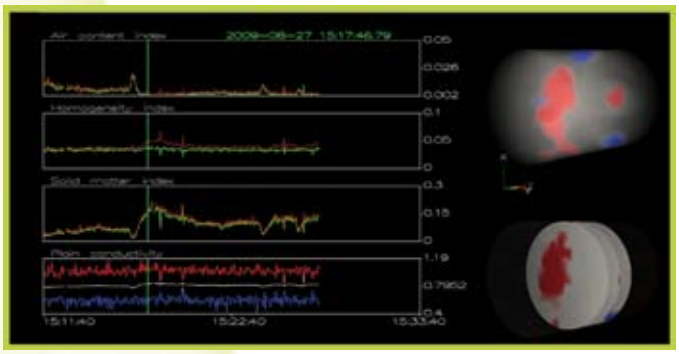

Fig. 5: **Air in the pipe may disturb the control loop of the process.**

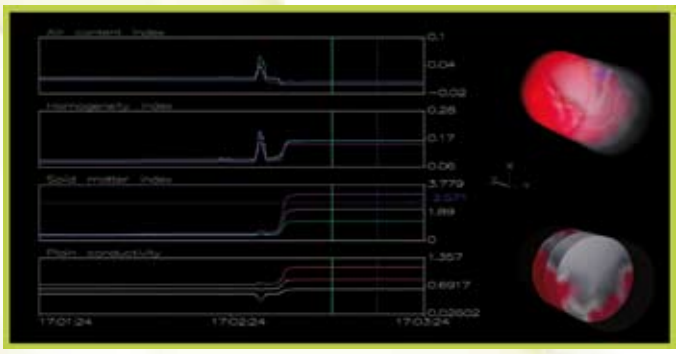

Fig. 6: **The homogeneity of the mixing process can be imaged using CoreApus and CoreTucane products.**

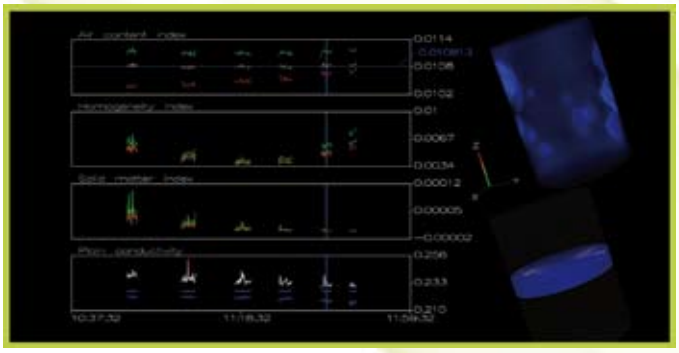

Fig. 7: **CoreApus image reconstruction and air content trends from gas injection**

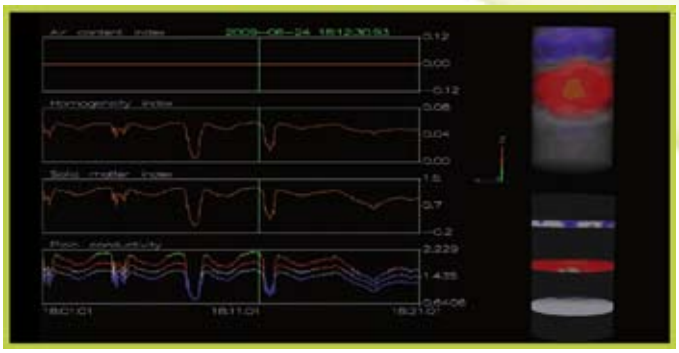

Fig. 8: CoreApus image reconstruction and trends from a column flotation cell process.

Service: Troubleshooting and measurement services

Numcore provides troubleshooting and measurement services for process industry. Measurement services include trials and feasibility studies during your R&D project to validate and shorten your project. The length of the tests depends on your application and the nature of project.

Numcore has a process laboratory in Kuopio, Finland. The laboratory is equipped with tomography systems for feasibility studies. Our process engineers are also available for troubleshooting and measurement services at your site.

Features and benefits

- Laboratory scale tests using the process laboratory in Kuopio, Finland
- Onsite testing using Numcore's product families and process engineers
- Validate results of R&D project
- Makes your R&D projects shorter and more cost effective

Please contact us if you would like to discuss more on specific applications.

Service: Validation of CFD results with tomographic imaging

Computational fluid dynamics (CFD) is widely used in process industry for studying the behavior of process tanks and vessels. In many cases, CFD is a valuable tool when developing and designing new products and improving processes. Tomographic imaging can be used to improve the accuracy of CFD. This is the case especially with multiphase models.

Tomographic imaging can be used together with CFD in validating computational results with real measurements. With Numcore's advanced data analysis tools, the actual flow fields within the target volume can be visualized. In addition, in multiphase flows the volume fractions and relative concentrations of different components can be determined.

CFD validation projects are carried out in collaboration with Kuava Ltd and Numerola Ltd.

Features and benefits

- Visualization of flow fields within the target volume
- Provides information on process parameters, such as viscosity, to improve CFD models
- Imaging of multiphase flows

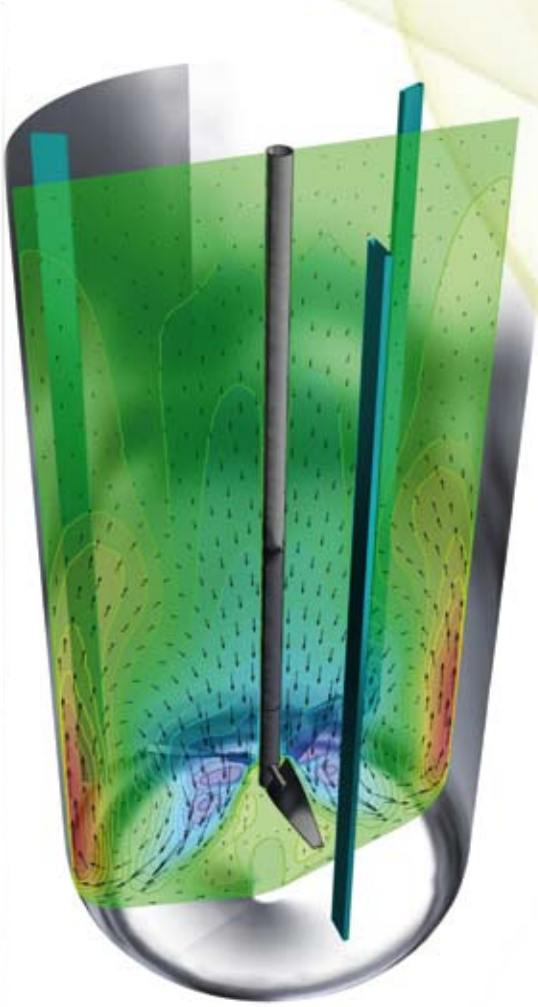

Fig. 9: **CFD computations can be validated using tomographic measurements.**

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