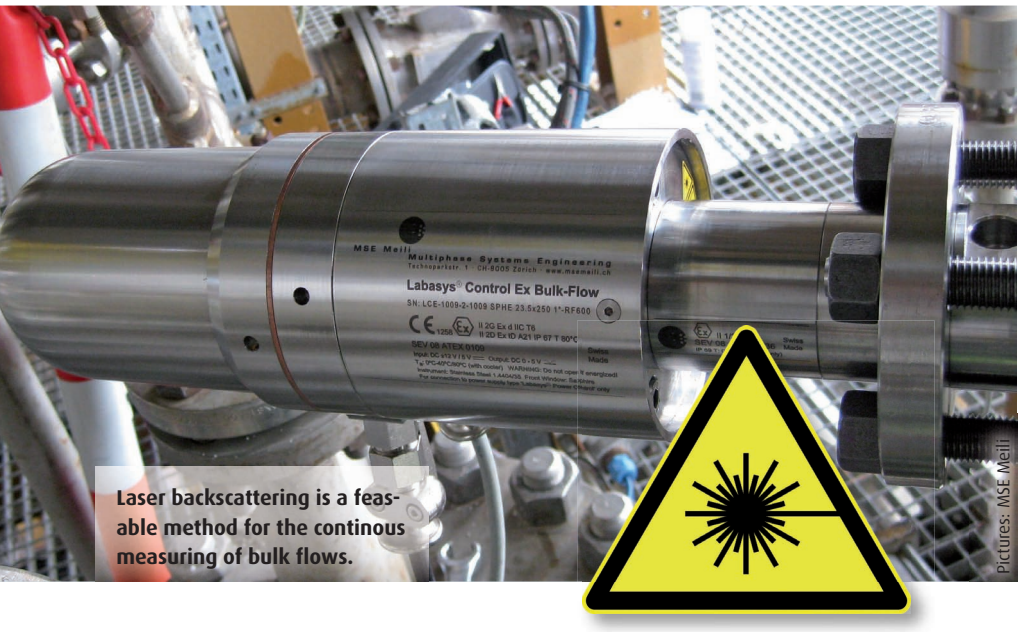
Illumination for Particles

Laser backscattering provides in-situ measurement of bulk flows



Laser backscattering is a feasable method for the continous measuring of bulk flows.

Pictures: MSE Meili

"Panta Rhei—everything flows" said the ancient Greek philosopher Heraklit—and although he did not consider bulk flow processes, their importance for the industry is immense. Measuring flow rates in a moving particle flux, at high temperatures or gauge pressure, is a difficult task. To run such processes at their optimum, laser backscattering instruments can be important tools.

DR. RETO T. MEILI

With respect to today's enhanced efficiency and environmental requirements, modern processes are often laid-out as 'solids loop processes'. Although having certain advantages, they are more difficult to handle and to control than liquid based processes. Examples for such solids loop processes are Fluid Catalytic Cracking (FCC) processes in refineries, chemical looping combustion or LyondellBasell's polypropylene process 'Spherizone'. All of these processes have at least one closed loop where solids circulate—be it in fluidized or in bulk form.

It is often important to measure the solids flow rate in such a loop in-situ. Since the loop may not be opened, this is in most cases not possible with conventional instruments as for example balances. Harsh conditions such as gauge pressures or high temperatures, as the 40 bar/100 °C of the Spherizone process, augment these difficulties.

To get a reliable measuring solution for their closed loop process, LyondellBasell prompted MSE Meili to develop a velocity meter on the basis of the existing Labasys instruments. The device should be suited for the Spherizone process and feature a genuine in-situ measuring solution.

A Challenging Task

An accurate insight into the internals of the process is necessary for the understanding and further development of the process and also to operate industrial plants at or at least near their optimum conditions. For this purpose the bulk flow velocity—a key quantity for the effective control—is measured. Developing a particle velocity measuring system for the Spherizone process was a challenging task due to its high requirements: The instrument needed to be Ex-protected, hold gauge pressures up to 42 bar as well as high temperatures. Furthermore, the outer diameter of the tip should not exceed 25 mm.

After comprehensive tests in a semi technical unit, the newly developed Labasys Control Ex Bulk Flow instrument was approved by LyondellBasell for industrial Spherizone plants. During 2008 the first instruments were successfully put into production in close cooperation with LyondellBasell.

To withstand the required harsh conditions, the tip of the stainless steel instrument has a sapphire window and a double sealing pressure barrier. All optical fibres are placed inside the device where they are protected against breakage. Using fibre optics has the advantage that signals are guided out of the rough process environment optically, making them insensitive to disturbances. The unit may withstand high pressures and temperatures up to 350 °C, since all electronic components are located in a flame-proof bulb at the back of the instrument.

In-Situ Laser Backscattering

To measure the particle flow, the Labasys instruments use laser backscattering. The particles are illuminated by laser light guided with optical fibres. A photometer converts the backscattered light into electronic signals. From there, the velocities are determined using cross correlation methods. The analysis software Labasoft Control evaluates about 20

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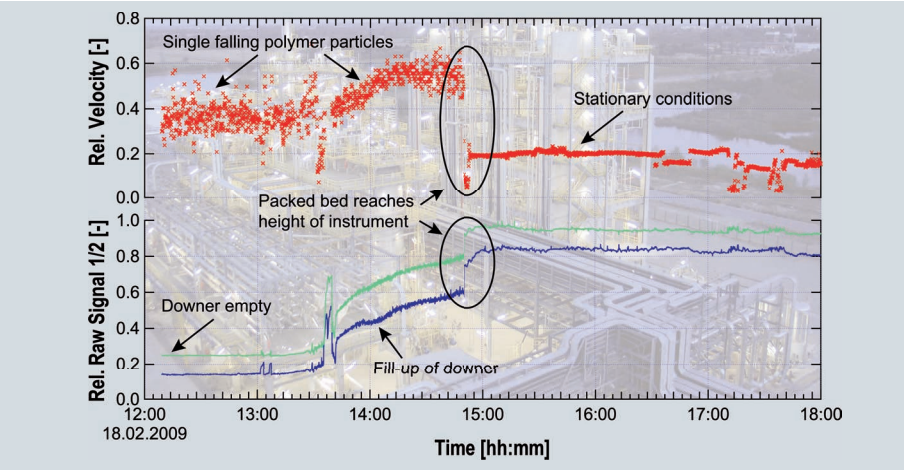
single velocities every four seconds, from which stable mean values are derived.

The chart to the right shows typical plant start-up data of a Spherizone process, measured in the downer. The red points show the target quantity velocity. The blue and the green markers below show the raw signals of channel 1 and channel 2 of the measuring instrument. These values correspond to the polymer concentration in the downer, allowing for a close observation of the start-up phase: when the plant is started at ca. 13:30 h, the filling level rises and the polymer particles start to circulate. The velocities of the particles falling onto the packed bed at the bottom of the downer fluctuate strongly and rise as their density rises, as indicated by the concentration signals.



Process data from the start-up phase of a Spherizone process

Slowly the filling level moves upwards and at about 14:50 h the packed bed reaches the height of the instrument. From this moment on the velocity of the bulk flow (which is much lower and more regular) is measured instead of the falling particles: the process reaches stationary conditions and only minor variations of the bulk velocity can be observed. The instruments also yield valuable concentration data—at least in qualitative form—which give direct insight into the inner life of the reactor.

By now instruments are in operation in LyondellBasell's semi industrial Spherizone plants in Ferrara and Frankfurt and in commercial plants in Thailand, Korea and Saudi Arabia. A reliable and long-lasting operation without costly product interruptions can be assured, as the with Swiss precision engineered, manufactured and tested instrument proved its value well in practice. Or as a supervisor of manufacturing platforms of LyondellBasell said: "We are happy with our three Labasys Control Ex Bulk Flow instruments. In the more than two years they were in operation at our plants now, they run perfectly well and delivered important in-situ information to control our processes efficiently."

These devices are also well suited to monitor velocities and concentrations in other solids processes—be it in the high concentration 'bulk flow' or in a more dilute flow range, be it in a R&D or an industrial production environment.

THE SPHERIZONE PROCESS

Inside the multi zone reactor

The heart of the Spherizone process is the multi zone reactor. It consists of a riser and a downer, which allows for two fully controlled but separate polymerisation conditions in one single reactor. That makes Spherizone a versatile reactor for polypropylene. The downer is filled with polypropylene particles of 2–3 mm diameter, which are moving downwards slowly. This flow may be described as a 'moving packed bed' or in other terminology as 'bulk flow'.