Use of miniLDV in Pipe Wall Shear Measuring

Drag reduction in oil pipelines has been researched for decades. Finding an effective way to reduce frictional and energy loss of pipelines by overcoming the pipeline drag due to turbulence, can bring a more efficient oil transport by increasing throughput, reducing the energy needed and subsequently should contribute to lower costs and higher profits for oil companies.

Any work related to the drag reduction, for example, in the oil pipe, requires the measurement of the wall shear. Measurement Science Enterprise Inc. (MSE) from Pasadena, USA has been designing for over 15 years various products based on Laser Doppler Velocimetry (LDV) principle. One of the most recent additions has been microPro - microprofiler designed specially to measure the wall shear in pipes and flow facilities of any size (US patent pending).

microPro

MicroPro is a near-surface micro profilometer shear stress sensor, measuring the wall shear using a near-wall traversing 1-D miniLDV with extremely small probe volume dimensions. It is designed to automatically locate the window surface location and obtain the mean velocities at a number of points within the log region and possibly within the linear region of laminar or turbulent boundary layer flows. The velocity data are then used to obtain the best estimate for velocity gradient at the wall. Knowing the coefficient of viscosity, the wall shear stress is then calculated.

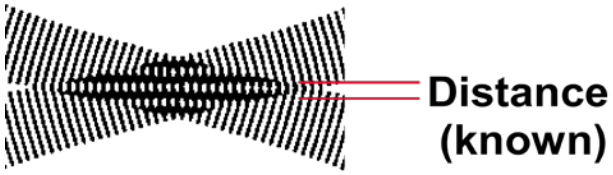
MSE's microPro shear stress sensor is small, self-contained and permanently aligned; no calibration required by the user. The probe contains a miniLDV, micro translation stage, and receiving optics.

Below is an example of an attachment for circular pipes. Custom attachment mechanisms will be provided for other flow facilities.

VISION ASIA TECHNOLOGY PTE LTD
14 ROBINSON ROAD #13-00
FAR EAST FINANCE BUILDING
SINGAPORE 048545
PHONE: +65-6451-1857 • FAX: +65-6323-1839
WWW.VISIONASIA.COM.SG

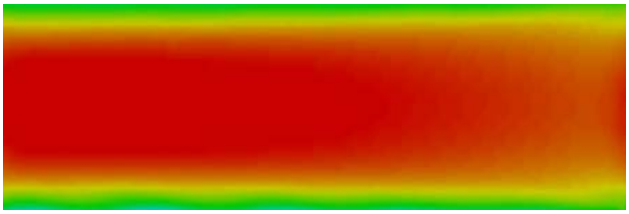
Principles of microPro

microPro probe contains a laser, miniature beam shaping optics, receiving optics, detection system, and an electronic traverse.

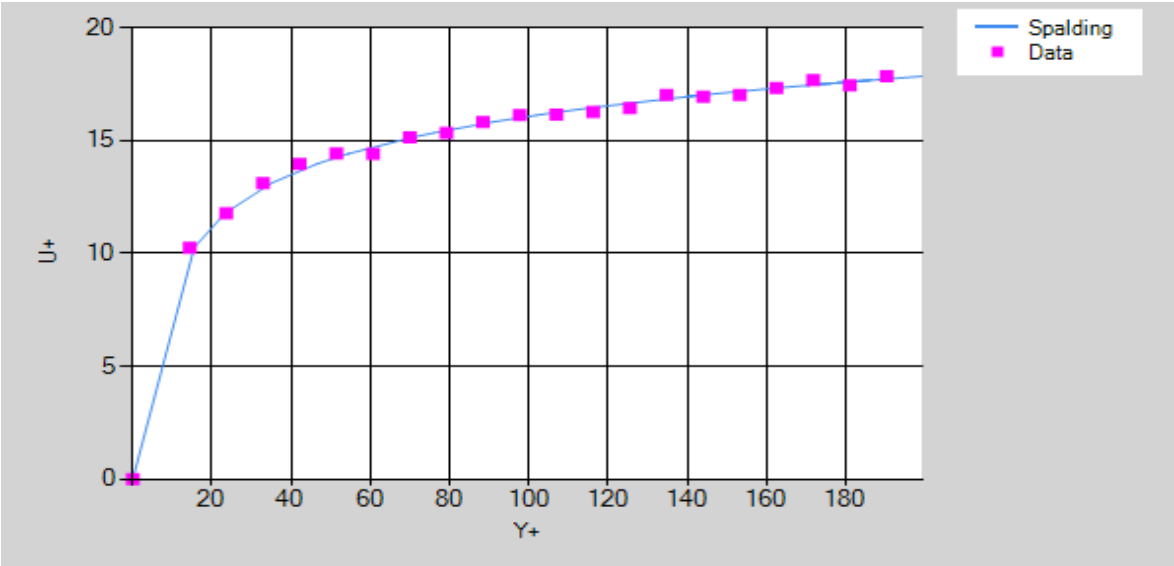


In LDV, two coherent laser beams are crossed (forming the probe volume) to generate interference fringes with known distance. When a particle or microscopically textured surface moves through the regions of constructive interference, it reflects bursts of light corresponding to its speed. Since the spacing between the fringes is constant, the velocity of the particle or surface is calculated using FFT technique. The mean and rms of the velocity is calculated from a population of samples collected at each location.

With an integral automated traverse, microPro automatically steps the measurement location (probe volume) through the boundary layer at very small step sizes, providing a direct measurement of the boundary layer velocity profile. In addition, the software performs a curve-fit of the data with classical profiles such as Musker and Spalding to calculate the velocity gradient at the wall. Given the viscosity of the fluid, it calculates the shear stress at the wall.



The included processing software automatically finds the location of the window, collects near wall boundary layer mean velocity profile, curve-fits the data and calculates the wall shear (see below). The steps of measuring the data can be as little as 50µm offering unsurpassed precision of measurement.



VISION ASIA TECHNOLOGY PTE LTD
14 ROBINSON ROAD #13-00
FAR EAST FINANCE BUILDING
SINGAPORE 048545
PHONE: +65-6451-1857 • FAX: +65-6323-1839
WWW.VISIONASIA.COM.SG