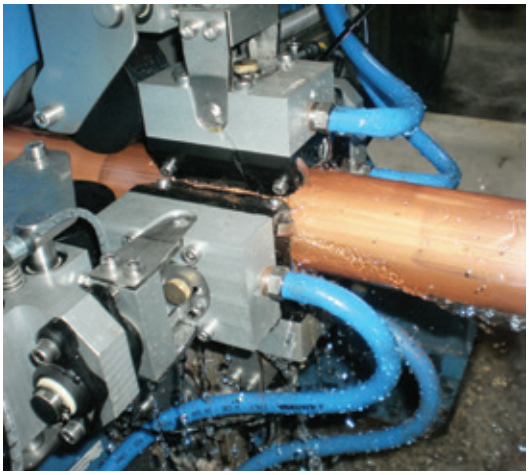
MAC system tests for eccentricity during tube drawing



Ultrasonic transducers positioned around a copper tube during eccentricity test

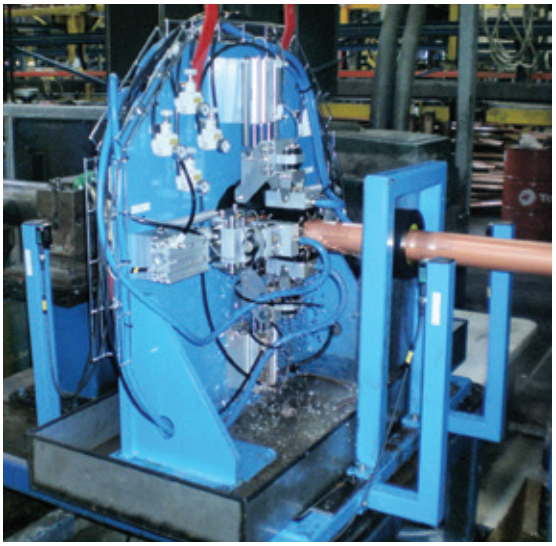
Instrument display showing A-scan of each thickness measurement, as well as charted data of two separate eccentricity alarms, min and max wall, and average wall

ECCENTRICITY, where the OD and ID are not concentric, is a problem that is most often created during extrusion of the billet before being drawn into a tube. Magnetic Analysis Corporation has recently installed a new Echomac® ultrasonic test system to measure eccentricity at a US copper tube mill that manufactures commercial and industrial grade tube and pipe. The company needed a way to measure eccentricity in a 2.125" OD master tube with 0.1" wall thickness, at speeds up to 600ft/min.

The UT inspection takes place after the extrusion process but while the tube is being drawn in a high speed draw production line, prior to further reduction. Eccentricity in the finished product can mean wall thicknesses that do not meet specifications, causing problems during further processing downstream. This test alerts the processor to this condition, and they can also use the test results to make adjustments to the process to improve concentricity. The Echomac® system supplied uses four transducers spaced 90^0 around the tube. This allows a very accurate calculation of eccentricity of a non-concentric tube, assuming the external and internal extrusion dies are round. A unique mechanical design is used that allows the transducers to track tube movement off centre. The transducer ride shoes use wheels to maintain consistent contact with the tube surface and a bubbler water system maintains the couplant for the ultrasonic energy. These shoes are mounted to air cylinders that close after tube entry and then retract prior to the tube back end exiting. This approach tracks the tube surface, and also prevents possible damage to the transducers and shoes from any misalignment of an incoming tube. An encoder wheel is also mounted to an articulating air cylinder, allowing accurate tube tracking and measurement for the Echomac® electronics. Springs are attached to all cylinders allowing a fail-safe retraction in the event of system air pressure loss. A urethane wiper assembly is mounted to the back side for water containment.

Four channel eccentricity testing is a special form of four transducer operation that is designed to measure wall variation based on four independent measurements made at four fixed points that are separated by 90^0 each around the tube circumference. The software uses trigonometry to construct a sine function with an offset. The offset is the average of these four wall measurements and is the tube's nominal wall thickness. The amplitude of the derived sine function represents the wall variation. Eccentricity is an expression of wall variation but the definition depends on the particular user and their agreement with their customers. An accurate minimum and maximum wall thickness is also derived, irrespective of the circumferential tube orientation under the fixed transducers. At this stage, the tube can have ovality as a characteristic due to draw track gripping but the eccentricity is an attribute of the wall thickness of the tube and ovality is ignored.

Test head for the Echomac® ultrasonic eccentricity test system recently installed at a copper tube mill



The raw wall thickness data under each test plane can be displayed for set-up purposes. Each computed channel is processed separately, including thresholds, alarming and recording. The user may set up four independent eccentricity threshold levels. The software gives five choices of eccentricity calculations to suit various customer methods. The operator can customise how data is presented by selecting the type of view for each of the four channels. In the Echomac® installation, two channels are set for different eccentricity sort levels while a third is used for a min-max thickness alarm, and the fourth monitors average wall. As proof that this four channel eccentricity method works, the average wall remains a constant regardless of the tube rotation and eccentricity value and is constant over large production runs.

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