

Major breakthrough in small grain copper tubes

UPCAST®-SGTube technology is able to cast fine grain DHP tube suitable for both sanitary and ACR tube production. Tubes ready for drawing come in heavy coils direct from the casting line. Drawing performance has been tested in conventional spinner blocks, giving high quality results in tubes with wall thickness of down to 0.4mm.

UPCAST Oy's R&D team built on UPCAST® technology's inherent advantages – low investment and production costs, near net shape casting performance and GREENerCAST features – to continuously cast tube with a fine grain ready for direct drawing in the conventional manner. The goal was reached by a complete redesign of the cooler-die construction and creating new casting stroke forms.

This technology, based on the submerged die casting technique, has evolved into a sophisticated continuous casting system for copper and copper alloys. The casting process is started up with the insertion of a steel 'fishing' rod with detachable copper or steel 'bait' at the tip. Upon its insertion, melt solidifies against the bait and the fishing rod is pulled upwards in strokes by the traction shaft and pinch roller. When the cast rod or tube passes the traction shaft level the fishing rod is removed and bait is cut away. The process is self maintained and the cast product is coiled in a rack or basket.

After several months of testing the tooling design and process definition reached the point where the sought after grain size was produced in a consistent manner. The cross-sectional pictures show how the cast grain structure changed from start to end of testing. Chemistry is same for both samples but there are marked differences in grain sizes and uniformity.

In sample "a" – cast with the conventional UPCAST® system – the grain size is non-



Cast tube (far right) and several drawing steps

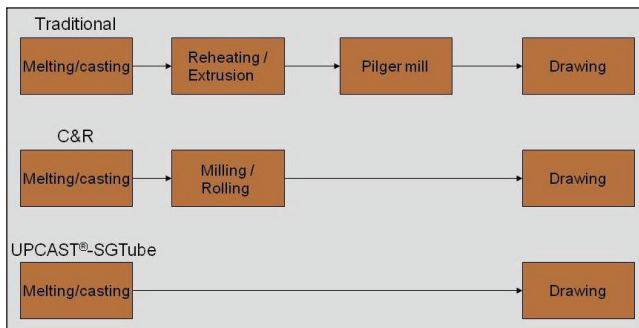
uniform and mostly big extending across the wall thickness making the structure rather vulnerable in drawing and bending. Any intergranular crack would easily propagate between the inner and outer surfaces of the tube resulting in rejection due to quality reasons. In sample "b" – cast with UPCAST®-SGTube technology – grain distribution is small and uniform. Grains are on average three to four times smaller than those in sample "a", and in no case there are grains that go all the way across the wall thickness. At micro level, it was also noticed that the dendritic structure was finer in sample "b". These characteristics predicted good performance in drawing.

Drawing was performed in nine passes – including one "sink pass" – using standard spinner blocks from initial OD38mm and 2.5mm wall thickness to OD8mm and 0.4mm wall thickness. There was one intermediate inductive annealing at OD25mm. Eddy current test was performed while final coiling was made, and as a last step there was bright annealing. Results at 0.4mm wall thickness were excellent, fulfilling all quality requirements.

At this point the primary objective of casting tube with a fine grain structure suitable for direct drawing to ACR tube sizes and quality was achieved.

Regarding secondary objectives, it was found that energy consumption for transforming cathodes into UPCAST®-SGTube was around 280Kwh/ton.

The potential for savings both in production and investment costs can be clearly seen by comparing necessary process steps for the



alternate technologies. In addition UPCAST®-SGTube represents a significant reduction of environmental footprint compared to the currently used technologies.

UPCAST Oy's R&D team has demonstrated that fine grain DHP copper tube can be cast consistently using UPCAST®-SGTube technology and that the quality level is sufficient for ACR tube production.

Additionally, the lack of any harmful emissions or waste requiring special disposal treatment reduce UPCAST®-SGTube's environmental footprint.

The company estimates that overall production costs will be a mere 30% of that of the best current alternative and investment per ton will be six to eight times smaller.

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Cross sections of cast tubes: a) Conventional UPCAST®; b) UPCAST®-SGTube