AMERICA'S FIRST D-H UNIT

Crucible Steel Co. of America recently demonstrated its new D-H vacuum degassing unit by processing a 170-ton heat of open-hearth steel at its Midland, Pa. works. The unit is the first of its type in the US.

The world's largest D-H degassing unit—the only one of its kind in the US—was recently demonstrated by the Crucible Steel Co. of America at its Midland, Pa., works. The D-H process, developed by the Dortmund-Hoerder Huettenunion of Dortmund, Germany (see May 1960 issue of JOURNAL OF METALS, p. 398), removes impurities from molten steel by exposing it to the pressure of an evacuated vessel.

Prior to the degassing operation, a ladle of steel is placed on a movable car and positioned under the treatment vessel. The pear-shaped treatment vessel contains a heating element which maintains the temperature at 2700° F under a pressure of about 0.001 atm. The vessel is supported on four piston-like legs and can be raised or lowered with three 75 hp motors.

At the start of the treatment, the vessel is lowered until its protruding refractory snorkel penetrates the metal in the ladle to a predetermined depth. A vacuum is then drawn in the treating vessel, and the degassing operation begins. As the vessel moves from the highest to the lowest position, the metal flows through the snorkel into the degassing chamber, and as the vessel reverts back to its original position, the degassing metal flows back into the ladle. The motion of the molten metal is held in phase with the moving vessel by a calculated adjustment of the vessel speed, stroke, and dwell.

With each completed cycle, approximately one-tenth of the total weight of the metal in the ladle is treated and recirculated. About 32 cycles are required to degas effectively a 170-ton heat before alloying. Alloy additions are made from the vacuum-tight hoppers located at the top of the vessel.

The final phase of the treatment consists of six mixing cycles to promote homogeneity. At the end of the degassing operation, the metal is adjusted to the correct teeming temperature, and transferred to the teeming area where the heat is cast into 12-ton ingots.

The flexibility and the low temperature loss of the process permit a wide variety of treatments to

achieve various objectives. Composition can be brought under unusually close control by the addition of small increments of alloys under vacuum conditions. Temperatures can be controlled by thorough mixing, control of the heater rod during treatment, additions of various alloys, and by adjustment of the treatment or holding time.

To date some 100 heats have been run in the unit at Crucible, and the following grades of steel have been treated; 1020, 1040-46, 1085-95, 4130, 4142, 4320, 4340, 5140-5160, 8620, 8640-45, 51100, 52100, and H-11. Maximum alloy addition has exceeded 2 pct with no associated problems, and it appears that two-to-three times this quantity could be added.

Recovery of the alloy additions has been very favorable thus far. This is best illustrated by silicon recovery. A recovery of 100 pct Si has been obtained on most heats. Chromium recovery has been averaging 97 pct, and manganese from 80 to 100 pct for small additions, and approximately 95 pct for larger additions. It is interesting to note that the chromium and manganese losses are due to volatilization rather than oxidation as evidenced by the high silicon recovery.

In addition to the high alloy recoveries, the process permits better chemistry-control than the usual open hearth practice, produces steels with consistently fine and normal grain sizes, removes flake, and shows significant improvement in micro-cleanliness. Gas contents of the treated steels have been measured; oxygen reductions have ranged from 55 to 90 pct, and steels high in nitrogen, lose about 25 to 33 pct of their nitrogen content during treatment.

Although the quality level produced by the D-H process is not quite equivalent to that of vacuum melted products, the tonnage that can be treated in a relatively short time span should definitely have an impact on the steel industry. Crucible officials hope that, as the capabilities of the unit are developed, it will open a whole new field of possibilities for producing new grades of steel and steels that are now confined to rather difficult specialized electric furnace practices.

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