Tellurium Contamination Causes Chill Problems

Recently, a foundry producing medium-sized gray iron castings for a corrosion resistant application experienced a sudden outbreak of severe chill problems. Chill in one section was so deep that some castings were unable to survive the normal shakeout practice without breaking into several pieces.

All of the chilled work was cast in green sand. The base metal is a nominal 30,000 psi iron, to which 1.8% copper additions are made. This level of copper is sometimes used where gray iron castings are used in mine water applications, oil refineries or where the iron is exposed to solutions of sulfuric or hydrochloric acid.

After reviewing several possible causes, the problem was attributed to the most recent batch of copper received by the foundry. Suspecting contamination of some type, several samples were forwarded to commercial laboratories. Typical impurities in copper, such as tin, lead, phosphorus and zinc, were all at normal levels, but a range of 0.25-0.32% tellurium was reported by both laboratories. By contrast, copper that had caused no problems analyzed at 0.10% tellurium or less.

With an addition of 1.8% of the contaminated copper, about 0.005% tellurium was input to the iron. According to the literature, this level of tellurium in gray iron should not be particularly problematic, except in the presence of hydrogen. Since the castings were made in green sand, there was a definite hydrogen source.

To try and illustrate the tellurium-hydrogen interdependency, a test was arranged to pour metal containing 1.8% of the contaminated copper into oil sand, nobake and green sand molds and compare results to those of normal copper additions. A chill wedge core, roughly equivalent to an ASTM 2C wedge, was used as the oil sand mold.

The results of the oil sand test are shown in Fig. 1. Note the definite chilled rim around the entire periphery of the wedge poured with iron containing 0.005% tellurium. The other wedge was quite normal. This was surprising, considering the absence of moisture.

Test castings poured in green sand molds are shown in Fig. 2. Results were identical to those produced in oil sand. The nobake test casting was a type of step-casting, with the thinnest section being about 0.5 in. thick. The casting poured with the contaminated iron was chilled throughout the 0.5 in. section, while the other casting was normal with no chill present.

There are several key points to be made from this exercise.

Know Your Source—Be careful of your incoming copper supplies. Purchase only to an adequate specification. In this particular case, in order to assure no future problems, the copper supplier tightened up his specification and revised his incoming material analytical procedures.

Tellurium Can Chill—Contrary to existing literature, tellurium can cause severe chilling in cases where we would suspect no hydrogen source, such as in oil sand or nobake molds. In fact, the degree of chilling was similar in all molding media.

Pour Chill Wedges—The tellurium contamination produced a very interesting chill pattern in the wedge core. A good case is made once again for pouring chill wedges on a regular basis. Although most foundries add far less than 1.8% copper and probably would never have had a problem, the unique peripheral chill caused by tellurium contamination is quite extraordinary and easily recognizable, should a similar situation ever occur again.


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Fig. 1. These oil sand chill wedges were produced to test the effects of tellurium contamination. The wedge on the left, poured with iron containing 0.005% tellurium, shows a definite chilled rim around the entire periphery. The other casting, containing no tellurium, is normal.

Fig. 2. Green sand iron castings testing the effects of tellurium contamination are shown. Casting on the left, containing 0.005% tellurium, shows chilling, whereas the casting at right, containing no tellurium, does not.