

couple with relation to HVT (3) a reading of a multiple high-velocity thermocouple (MHVT).

The MHVT—a delicate laboratory instrument not practicable for everyday tests under operating conditions—registers within a few degrees of the true gas temperature. HVT, a more rugged tool capable of use under actual operating test work conditions, may easily be corrected by the use of curve. True gas temperature or MHVT value, then, may be used in design work.

Both HVT and MHVT have the metal junctions shielded from the direct effects of radiant heat. Gas is aspirated over them at increasing velocity until the reading levels off.

Differences in temperature, such as indicated on the curve throughout the range shown, are normally encountered in furnace exit gases. For this reason temperatures of this order should not be specified without also defining the method by which they are taken.

Ash Characteristics. In the design of the pulverized-coal-fired furnace, ash influences a designer's work probably more than any factor he contends with. He cannot know too much about it.

A notable contribution to clearer thinking on furnace design or specifications can be made if initial deformation, softening and liquid temperatures of ash on an oxidizing as well as a reducing basis are given.

SPECIAL SECTION POSTPONED

Unsettled conditions in the printing industry make it necessary to postpone the 16-page Special Section on low-voltage electrical protective devices scheduled for June POWER. If circumstances permit, it will appear in July.

Back in the days when stoker firing predominated, a laboratory procedure was established with the objective of determining the clinkering properties of coal when burned on grates. It involved the determination of these ash temperatures in a reducing atmosphere and this procedure is still the standard laboratory practice today. Under the circumstances prevailing then, this method made sense because it attempted to set up in the laboratory the conditions under which the clinkering took place. Today, however, with pulverized coal firing, tight furnaces, and excess air admitted at the burner except for the zone of highly active combustion, the ash particles are in an oxidizing atmosphere.

At the 1940 annual meeting of the ASME, Bailey and Ely presented data on the considerable difference in these ash properties when determination was

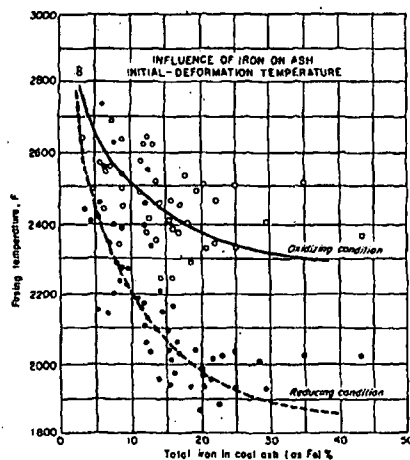
in an oxidizing compared to a reducing atmosphere; differences were much greater as iron content of ash increased.

Fig. 4 and 5 show, from a wide variety of coal ash samples tested over a period of eight years at the B & O laboratory, that the lowest initial deformation on an oxidizing basis that has been found is about 2250 F.

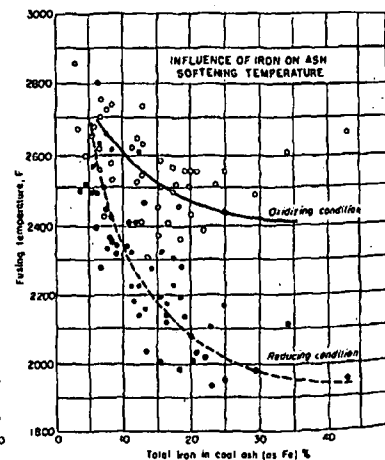
Since the fuel is burned and the ash passes to the furnace exit in an oxidizing atmosphere it would seem more realistic for us to talk and think in terms of ash temperatures on an oxidizing basis and so have the values we use more in keeping with the phenomena we are describing.

Experience and tests tell us that when the average true gas temperature entering close-spaced tubes exceeds the oxidizing initial deformation temperature of the ash, troublesome slag accumulations may be expected.

Summary. Control of the temperature of gas leaving the furnace is a highly important aim of the specification writer. All the above is a plea for realistic thinking on this and other related design requests in this phase of the power field. Realistic thinking involves using (1) terms that apply (2) measurement methods that can be adapted to expected operating conditions (3) a full story on the characteristics of the fuel, especially where they predict fuel behavior in service.



4 Initial deformation of ash on both oxidizing and reducing bases helps set furnace limits for pulverizer and stoker

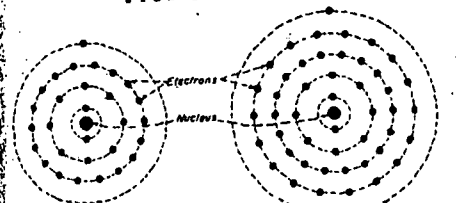


5 Pulverized coal burns in an oxidizing atmosphere so supply ash-softening temperatures on this basis in specifications

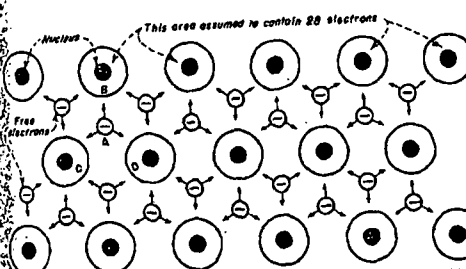
ELECTRONICS FOR THE POWER ENGINEER

By F A ANNETT, Associate Editor

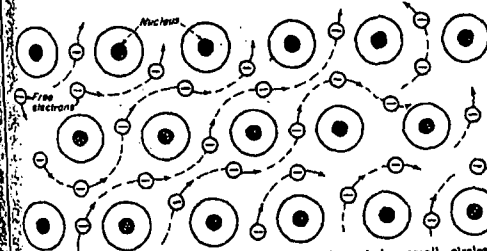
Free Electrons



Copper atom has 29 electrons: 28 in 3 inner orbits, one in outer



How free electrons—represented by small circles—in outer orbit of copper atoms may be influenced by the nucleus of two or more atoms



Arrows show how the free electrons—indicated by small circles—drift at random from one atom to another in the outer orbit of atoms

2—Electron Flow in Conductors

Not so long ago textbooks told us that the precise nature of electricity was not known, that it was an invisible and mysterious agent manifesting itself in many ways. Today we know that this invisible and mysterious agent is a flow of particles called electrons, which form part of all atoms. In the first lesson (POWER, April, p 105) we learned that the atoms of all elements are made up of a positively charged nucleus, or center, about which in orbits negatively charged electrons rotate. We also learned that their arrangement in these orbits gives each element certain chemical qualities.

With this conception of the atom's structure, let us consider electric-current flow in a circuit, as well as other effects. Flow of an electric current is now accepted as being a slow drift of so-called free electrons through a conductor. How these free electrons are made available has not yet been definitely established. One of the most rational conceptions maintains that electrons in the outer orbits of a conductor's atoms may at times be subjected to equal influences of two or more atoms.

Free Electrons. The structure of good-conductor atoms gives a clue to the free-electron theory. For example, consider the copper atom, Fig. 1, which has 28 electrons in three inner orbits and one in an outer orbit. The inner-orbit electrons are closer to the nucleus than the outer ones. The three inner orbits also have their full number of electrons, which is a stable condition; they do not have a tendency to lose or gain electrons, as explained in the April issue.

For these reasons the inner-orbit electrons are bound more tightly to the nucleus than the single electron in the outer orbit. This single electron, outside of the three highly satisfied family circles, appears to be more