

HEAT AND MASS TRANSFER IN METALLURGICAL SYSTEMS

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The materials men work with have characterised their societies since the beginning of pre-history. Historians indeed speak of the Stone, Bronze and Iron Ages; and to call our present times the Plastic Age is to make a significant, if exaggerated, comment. The comment is too extreme because metals are still among the most important of our structural materials, whether embedded within concrete for the construction of buildings and bridges, or thinly covered by paint when used for automobiles and ships, or accessible to the eye in the fuselage of an aircraft or in a domestic cooking utensil.

It is therefore not surprising that, in 1980, the International Centre for Heat and Mass Transfer devoted a symposium to the study of the role of its science in the manufacture, processing and use of metals.

Typically, metals are found in nature only in chemical combination with oxygen, chlorine or some other element. In order to separate them, heat must be applied, as in the blast furnace which separates iron from oxygen; or electrical power must be supplied, as when aluminium is electrolysed from its molten oxide, or sodium from its chloride. In all cases, transfer of mass must occur, for example in order that the oxygen can forsake its metallic partner in order to combine with carbon. Often the heat and mass transfer processes are complicated by the presence of phase change, as when bubbles of gas are formed at an electrode immersed in molten ore.

Once converted to the metallic state, metals are repeatedly subjected to further thermal and mass-exchange processes. Molten iron is poured into a Bessemer Converter, through which oxygen gas is blown, in order to effect the reduction of carbon content that turns it into steel; and the mechanical properties of the steel can be significantly improved by carefully timed heating and cooling processes such as "quenching" and "tempering".

The finished metal products must subsequently often resist exposure to extremely high and extremely low temperatures, usually in rapid succession; and the magnitudes of stresses which sometimes cause failure of the material depend on the manner in which heat is transferred internally.

The proceedings of the 1980 Symposium reflect the above-mentioned relationships between the science of heat and mass transfer and technology of metallurgical processing. The blast furnace was the subject of 7 papers, and other iron and steel

processes the subject of 6 more; then 5 papers were directly related to processes for winning non-ferrous metals from their ores. Further contributions concerned such more specialised topics as mathematical modelling, crystallization and heat and diffusion treatment. Lastly, and not inappropriately, a session was devoted to that process by which metals, having served their purpose, revert to something like their original chemically-bound state. The process is corrosion, a mass-transfer phenomenon of which the prevention or control could save mankind much expenditure.

To select a paper of especial excellence from so many valuable ones is not easy. My choice falls on that of Professor Julian Szekely, entitled "Transport processes in agitated ladles: problems, solutions and experimental techniques." Its author has made it his special concern to apply systematically to metallurgical processes the techniques and insights which have been regarded with much success; and he can truly be regarded as a significant benefactor to the metallurgical industry, as well as to research workers in heat and mass transfer.