Properties, Characteristics and Uses of Stainless Steel.*

THE investigations on this important development of metallurgy during the last 25 years, and particularly after the war, have resulted in many brands of stainless steel, called by several names. It is, therefore, not surprising that Mr. Main should have found it difficult to give a single definition for stainless steels. The two varieties of this class of steel dealt with by the lecturer are really typical of this class. Now that there are several makes of almost the same kind of product, having practically the same chemical composition, it would perhaps be misleading to classify all of them under the same category. It would be better to name them by the chief characteristics which they possess such as acid-resisting, rust-free, heat-resisting, etc.

The chief characteristics of plain chromium steels largely used in the manufacture of cutlery have been dealt with in detail and attention is drawn to the prevailing belief that ordinary carbon steel gives greater hardness to the cutlery and retains it better than the stainless type. If stainless steel cutlery has to maintain the same reputation as plain carbon steel product and still be competitive with it, it would serve no practical purpose to improve hardness by adding other valuable elements and thus adding to the cost. It is a point for investigation if carbon itself could not be increased beyond the present limit of 0.35 per cent. keeping the chromium content round about 14 per cent. It is of course practically impossible to handle a product like the above with our present methods of heat treatment and new methods of working will have to be developed. This would incidentally help a larger use of the cheaper grades of high-carbon ferro-chrome.

There is no doubt that for decorative and household use the famous "18–8" variety is best suited. Here again the presence of a large quantity of nickel is making the product very expensive. The question whether an improved technique for the manufacture of stainless irons could be developed so that a cheaper substitute may be made available for the chrome-nickel type of stainless steel, deserves investigation.

Considerable work is at present being done in important Institutes of research with a view to determine the relative merits of different metals and alloys for containing foodstuffs. The author's statement that there is not the slightest fear of food contamination and consequent poisoning, in stainless steel vessels and that there is no anxiety on this score is very assuring.

The use of stainless steels in the chemical industries is perhaps much more extensive than in other fields. Almost all the important industries use this material in greater or smaller degree, and it is believed that the high initial cost paid for the stainless steel equipment is more than compensated by the saving due to absence of frequent repairs and renewals. It is hoped that in course of time some modified form of chrome-nickel stainless steel will be evolved which would resist the action of the two important acids, *viz.*, sulphuric and hydrochloric, which easily attack the present brands of stainless steel.

In the field of mechanical engineering the use of plain chromium steels is becoming more and more common. Most of the high pressure steam turbines have blades made of a special type of chromium-nickel steel. Pump impellers and parts of automobiles and aeroplanes are made of stainless steel. The stainless steel train referred to by the author is of special interest since the deterioration on ordinary steel trains due to corrosion is stated to be on the increase. Apart from the decrease in weight of the carriages, the absence of annual cleaning and painting and complete renewal perhaps once in about 12–15 years should make it worth while to take up a thorough investigation of the overall relative merits of the two types of rolling stock at least for fast express trains.

A reference is made to a series of new cheap alloy steels which resist corrosion better than the plain carbon steels, chiefly copper and copper chromium steels. But it is doubtful if any reasonably cheap steel could be produced which would be rust-free and at the same time capable of being rolled into the numerous sections used in structural Engineering.

A brief reference has been made to the manufacture of stainless steels, and the several manipulative processes required for finishing them. A passing mention may be made here of the new direct processes for manufacturing stainless steel. It is true that several of the present patents cannot be strictly called commercially successful, but one or two processes especially Wild's process, seems full of promise. The mechanical working of steel after the ingot stage has been receiving considerable attention and any improvement in the mechanical equipment handling this type of steel with a view to minimise rejections should be welcome. After all the demand for this type of special product is largely guided by the price at which it can be sold, and attempts must therefore be made in the direction of cheapening the cost of production during the several stages of manufacture.

The theory of protective film produced naturally on the steel, advanced by the author, is full of interest. The popular impression of stainless steels was that the stainless character is in the substance itself rather than due to any protective coating on the outside. The claim put forward by the manufacturers of stainless steel products that these products are superior to those having special coatings of chromium or nickel was largely based on this belief.

The several practical details given by the author in relation to cutlery steel, temper colours and the non-magnetic character of nickel steel, and the precautions that should be observed in working them should be very useful to the user of this class of steels. Reference to the recently discovered defect of intergranular corrosion when fabricating stainless steels and the special methods of overcoming it is also of practical value.

The future of stainless steel depends largely on the extent to which it can compete with its likely rivals in chemical industries and household utensils, these rivals being brass, bronze and

* "Properties, Characteristics and Uses of Stainless Steel," Lecture by S. A. Main, B.Sc., F.I.P., Royal Society of Arts, 1935, 83, 672.

aluminium. The next step in the development of this class of steels should therefore be mainly in the direction of cheapening the cost of production. One method is to perfect the several practical details connected with the direct processes referred to above. These processes will involve the use of lower grades of chrome ore, thus conserving the richer chromium resources of the world for only highly specialised products. Just as the iron ores containing round about 30-35 per cent. of iron were considered 50 years ago as being quite uneconomical for conversion into iron, while now the same class of ore is largely used in blast furnaces in England and on the Continent, similarly the development of suitable methods for economical utilisation of large deposits of low grade chrome ores should prove of considerable help.

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Science Notes.

A Note on the Sapogenin from Soapnuts.—Dr. S. V. Shah, Rajaram College, Kolhapur, writes under date 16th November, 1935 : "On referring to literature one finds that work on this sapogenin was begun by Winterstein and co-workers (Hoppe-Seyler's *Zeit. Physiol. Chem.*, 1911, **75**, 427 ; *Helv. Chim. Acta*, 1919, **2**, 198). But more recently W. A. Jacobs took up the same work (*J. Biol. Chem.*, 1925, **63**, 621 ; **64**, 379).

"According to Winterstein the sapogenin is a neutral optically inactive product having the molecular formula $C_{18}H_{28}O_3$, molecular weight 280, and melting point 319-320°. Jacobs described it to be dextro-rotatory [$(\alpha)_D$, 81°; l=1.009 in pyridine] and acidic in nature as it yields a sodium salt, and to have the molecular formula $C_{31}H_{50}O_4$. He thus found it to be exactly identical with hederagenin of Van der Haar (*Ber.*, 1921, **54**, 3142). For a moment one could argue that Winterstein's product was impure and as suspected by him was a mixture and the reduced optical activity was not observed in dilute solution.

"Further on treatment with concentrated nitric acid, Winterstein obtained from the sapogenin 1 : 5-dinitro- and 1 : 8-dinitro-naphthalenes. This appears more in support of Winterstein's than Jacobs' formula, as the removal of 21 carbon atoms from the molecule by nitric acid is rather unexpected. Windaus and Shah, Windaus and Linsert (*Zeit. Physiol. Chem.*, 1926, **151**, 86 ; 1925, **147**, 275) could not remove by this method more than five carbon atoms from oxydigitogenic, digitogenic and gitogenic acids. On the other hand, a degradation by eight carbon atoms (from 18 to 10) accepting Winterstein's formula appears more probable also according to recent work. Tschesche (*Ber.*, 1935, **1393**, 1412) has shown that the skeletons of digitogenin gitogenin and tigogenin have a side chain of eight carbon atoms in addition to four hydrogenated rings. In the case of these genins it is this side-chain which is attacked by nitric acid with the removal of five carbon atoms. By analogy, it is more probable, that, in the case of the soapnut sapogenin, eight carbon atoms would be removed by nitric acid instead of twenty-one carbon atoms thus supporting more the Winterstein's than Jacobs' formula for the sapogenin."

An Iron Horse from the Central Provinces.—Among the exhibits that were shown and commented upon at the ordinary monthly meeting of the Asiatic Society of Bengal, held on Monday, the 2nd December, was an iron horse. This exhibit which was shown by Sir Lewis Fermor "was obtained some 32 years ago from the top of a hill of manganese-ore in the Chhindwara district. The manganese-ore cropped out in large black masses, which in one place had been daubed with red paint and treated as a village god. Lying about were a number of clay horses and an iron one. This hill has since been worked as a manganese mine, and is now represented by a large hole in the ground.

The interest of this specimen is perhaps threefold. In the first place it has been exposed to the moist air of Calcutta for over 31 years, without any appearance of rust, from which one can deduce that it is made of very pure iron, as in the case of the iron pillar at Delhi. Its age, of course, is unknown.

The second point of interest is that it must be regarded as an example of primitive art. It is made mainly from three pieces of iron—one piece forming the head, the body and the tail, another piece the front pair of legs, and a third piece the hind pair. The way in which the pairs of legs are bent over the body provides a representation of a saddle. In addition, there are two extra small pieces of iron welded on to form the ears. Two touches of vermilion on the head suggest the eyes. The horse is so constructed as to be unstable when standing on its four feet, but to be stable standing on a tripod consisting of its hind legs and tail. It is a little over 7 inches long, and is in consequence less than one hand high

I have shown this horse on occasion to many people, and no one appears to have seen a similar horse before, but—and this is the third point of interest—it has been suggested to me that it should be compared with the horses that are offered to the Southern Indian village deity known as *Iyenar*—a beneficent male deity, who is regarded as the village watchman and whose duty is to patrol the village and fields at night. If this suggestion is correct, it is an indication of the extension of this South Indian deity as far north as the Chhindwara district in the Central Provinces. An account of *Iy nar* is given in Bishop Whitehead's "Village Gods of Southern India". These village gods, according to Bishop Whitehead, date from before the Aryan invasion and must be regarded as Dravidian deities. The Gonds of the Central Provinces are, of course, Dravidians, and it is not, therefore, surprising that worship of this deity *Iyenar* may have extended to the Central Provinces. I was not, however, given any name for the deity, and have no knowledge whether there is any local name for *Iyenar* in the Central Provinces."