History and Status of Development of Welding Consumables in the Country

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The first historical landmark for welding as far as India was concerned was in the year 1935. It was in this year that the Indian Railways undertook strengthening of a few bridges by welding. Besides this, the Railways carried out some experiments on welding and the conclusions were presented in the form of two papers at the Proceedings' Symposium on the Welding of Iron and Steel held in London in 1935. In the same year, the North Western Railway published specifications for metallic arc welding as applied to mild steel bridge work.

The first electrode plant with British collaboration was put up in Calcutta in the year 1935. It produced fully extruded rutile type electrodes for the first time in the country. Otherwise the demand was mostly met by imports from U.K. and other European countries. In 1951, a plant was put up in Bombay with Swiss collaboration to make the entire range of electrodes including low alloy, stainless steels, hardfacing, etc. From 1960 onwards there was a big addition to the number of electrode manufacturers having technical ties with leading firms in Switzerland, Germany, Holland, etc. Now the present position is that entire range of arc welding electrodes for mild steels, low alloy steels, hardfacing, stainless steels, cast iron, aluminium, copper, monel, nickel, etc. are indigenously manufactured in the country.

Manual metal arc welding will continue to be the predominant method of welding for a number of years in our country. In the developed countries today the percentage of manual welding to other welding processes is approximately 70 to 80%. It is expected that in India this ratio will not fall below 85 to 90% even in the next ten years and thus it is essential to note that manual arc welding will play a major role.

R & D efforts for import substitution of many manual arc welding consumables had a very early start in the country triggered by the demand of numerous types of new products which were being made in the country for the first time. For example, in the manufacture of blast furnace bells, the surface of the bell were being built up with a cast consumable called, 'SORMITE' which had to be imported. The challenge was taken up by a few manufacturers and import substitutes were developed at very short notice and today we can be proud that entire build-up is being done with indigenously developed consumables. In another steel plant, shear blades of a capacity of 3000 tonnes were being built-up with imported consumables. Vigorous efforts to substitute this was made and now all rebuilding is being done with inigenous consumables. When manufacture of HK-alloy reformer tubes were set up in the country, demand for new types of electrodes for the fabrication of these tubes came up and these have been successfully developed and tonnage quantities of these electrodes have been used up both in the fabrication of new tubes as well as in rectification work. Quite a number of such examples can be cited but only a few select items have been referred to here.

There do exist some very small gaps in the manual metal arc consumables field and indigenous R & D efforts are geared up to meet these challenges. Mention

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should be made here of some of the difficulties encountered in certain raw materials when it comes to development of very critical electrodes like, for instance, low temperature applications. It is necessary that both the core wire used as well as the ferro-alloys used in the coatings should have very low carbon, sulphur and phosphorus and it is essential that a special look is given to such requirements and import of such wire and raw materials are allowed so that top quality, consistent products are given for such critical applications. This is all the more essential since demand due to fabrication of offshore drilling platforms and containers for LPG will arise in the near future and demand for such products will also increase considerably.

Next to manual metal arc welding, the important process in our country is the S.A. welding process. It is estimated that nearly 2,000 S.A. welding machines are in use throughout the country and the demand for wire and flux has been estimated at about 3,000 tonnes. Bulk of the wire and flux requirements for welding of mild steels and high tensile steels are already being manufactured in the country. Some of the alloy wires like ½ Mo wires, 1 Cr-½ Mo wires are also being made in the country. Disincentives for the manufacture of further alloy wires like 2¼ Cr-1 Mo, 5 Cr-½ Mo and Ni bearing wires is the lack of volume demand for such wires. With the setting up of many mini steel plants, it is possible to make all these wires, but to make solid wires of these compositions the requirements will have to be of certain minimum quantities so that it becomes economical for manufacture. In Europe, flux-cored wires of such compositions are available for S.A. welding and since flux-cored wires manufacture has started in our country, it would be an easier approach to make such wires and offer them for S.A. welding. As regards the fluxes for S.A. welding, there are a number of manufacturers of both agglomerated fluxes and fused submerged-arc fluxes but for certain critical applications, fluxes are still being imported. It is possible to develop these fluxes also and, for this purpose, the major users of these fluxes have to help out the flux manufacturers by extending facilities for on the-job testing for it is not possible to exactly simulate the testing conditions in a laboratory and what proves good in a laboratory may not work on the job very well. The development work on fluxes has to be intensified so that we are 100% self-sufficient in this field in the next few years.

Next to manual and submerged-arc welding, the important process in use in our country is the MIG CO_2 process. This process has the fastest growth rate in the developing countries as well as in Russia, and India should be no exception, particularly because three or four companies have started on manufacture of MIG welding machines in the country. It is estimated that nearly 3000 machines are installed throughout the country. The major consumables used in this process are either solid wires with high Mn and Si content as deoxidisers or flux-cored wires as well as CO_2 gas. A few manufacturers have been marketing solid CO_2 wires and with the widespread usage of this process, more people will start making these wires and these wires should be easily and readily available in the market.

Another major consumable is the CO_2 gas. Although in the beginning, there were some complaints on the quality of gas, it appears from the good usage of this process, the quality of CO_2 gas has improved and it appears to be less of a problem. It is necessary that with regard to use of mixed gases for MIG welding which at present nobody is marketing, top priority be given for undertaking the marketing of such gas mixtures. Although CO_2 is the standard shielding gas for production welding of steel, it is sometimes advantageous to use a shielding gas consisting of a mixture of argon, (A) and CO_2 (A+5 to 20% CO_2). This mixture of two gases still permits individual gases to exert their own influence on the welding arc, metal transfer and weld pool and thus it is possible to retain with an A-CO_2 mixture some of the deep penetration effect of CO_2 with the smooth metal transfer behaviour of argon. Despite the consideration of economics (A+CO_2 is much costlier than CO_2) some advantages of such mixtures can provide technical solutions to welding problems and the use of a standard Argon+20% CO_2 mixture can be justified despite the higher basic costs of the gas.

Regarding consumables for electroslag welding, bulk of the consumables are being imported for the present. As this process gets popular and increased demands are made, the necessary consumables will be developed and marketed. As it is, some consumables for electroslag welding are already available in the country. An ISI standard is being formulated for electroslag wires and once it is finalised, all these wires can be made available provided again the volume allows for economic manufacture of the same.

Regarding the consumables for soldering and brazing, the country is self-sufficient for general requirements, but sophistication is required to be developed in respect of induction, resistance, blanket and continuous production-line application for brazing.

All the welding consumables are made to meet national and international standards wherever they exist.

A list of the Indian standards on welding are given in the appendix.

Many of the welding consumables are covered by the ISI certification mark. This ensures that consistent quality is maintained in production. Many of the consumables have also been approved by the internationally recognised inspection authorities such as Lloyds Register of Shipping, Indian Register of Shipping, etc. The inspecting officers from these institutions carry out annual checks on the products and also control various critical fabrications involving these consumables. Because of this international recognition of quality, Indian producers have been able to export their products to various countries in West Asia, Africa, South-East Asia, etc.

The above is a short review of the position of the consumables for the above processes of welding and brazing but does not cover perhaps the consumables used in other processes of metal joining. It is only because the other processes are in use in such a small percentage that it is difficult to get any statistical information on these processes and hence these have not been fully covered. But keeping in view the rapid development of industry, it can be predicted that usage of more and more sophisticated welding processes will become more widespread which in turn will trigger a demand for sophisticated welding consumables.

INDIAN STANDARDS ON WELDING

IS : 210-1970 Specification for grey iron castings

IS : 226-1975 Specification for structural steel (standard quality)

IS : 276-1969 Specification for austenitic manganese steel castings

IS : 617-1975 Specification for aluminium and aluminium alloy ingots and castings for general engineering purposes

IS : 800-1962 Code of practice for use of structural steel in general building construction

IS : 803-1976 Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks

IS : 812-1957 Glossary of terms relating to welding and cutting of metals

IS : 813-1961 Scheme of symbols for welding

IS : 814-1974 (Part I) Specification for covered electrodes for metal arc welding of structural steel (Part I-for welding products other than sheets)

IS : 814-1974 (Part II) Specification for covered electrodes for metal arc welding of structural steel (Part II-for welding sheets)

IS : 815-1974 Classification and coding of covered electrodes for metal arc welding of structural steels

IS : 816-1969 Code of practice for use of metal arc welding for general construction in mild steel

IS : 817-1966 Code of practice for training and testing of metal arc welders

IS : 819-1957 Code of practice for resistance spot welding for light assembles in mild steel

IS : 822-1970 Code of procedure for inspection of welds

IS : 823-1964 Code of procedure for manual metal arc welding of mild steel

IS : 961-1975 Specification for structural steel (high tensile)

IS : 1024-1968 Code of practice for use of welding in bridges and structures subject to dynamic loading

IS : 1030-1974 Specification for carbon steel castings for general engineering purposes

IS : 1179-1967 Specification for equipment for eye and face protection during welding

IS : 1182-1967 Recommended practice for radiographic examination of fusion welded butt joints in steel plates

IS : 1261-1959 Code of practice for seam welding in mild steel

IS : 1278-1972 Specification for filler rods for gas welding

IS : 1323-1966	Code of practice for oxy-acetylene welding for structural work in mild steel
IS : 1393-1961	Code of practice for training and testing of oxy-acetylene welders
IS : 1395-1971	Specification for molybdenum and chromium—molybdenum-vanadium low-alloy steel electrodes for metal arc welding
IS : 1851-1961 (Part I)	Specification for arc welding transformers (Part I-single operator type)
IS : 2062-1969	Specification for structural steel (fusion welding quality)
IS : 2680-1964	Specification for filler rods and wires for inert gas tungsten arc welding
IS : 2751-1966	Code of practice for welding of mild steel bars used for reinforced concrete construction
IS : 2811-1964	Recommendations for manual tungsten inert-gas arc welding of stainless steel
IS : 2812-1964	Recommendations for manual tungsten inert-gas arc welding of aluminium and aluminium alloys
IS : 2856-1974	Specification for carbon steel castings suitable for high temperature service (fusion welding quality)
IS : 2879-1975	Specification for mild steel for metal arc welding electrode core wire
IS : 2927-1975	Specification for brazing alloys
IS : 3016-1965	Code of practice for fire precautions in welding and cutting operations
IS : 3023-1965	Recommended practice for building up by metal spraying
IS : 3408-1965	Method for non-interrupted creep testing of steel at elevated temperatures
IS : 3409-1965	Method for creep stress rupture testing of steel at elevated temperatures
IS : 3503-1966	Specification for steel for marine boilers, pressure vessels and welded machinery structures
IS : 3525-1966	Code of practice for use of metal arc welding for hull construction of merchant ships in mild steel
IS : 3589-1966	Specification for electrically welded steel pipes for water, gas and sewage (200 mm to 2000 mm nominal diameter)
IS : 3600-1973 (Part I)	Method of testing fusion welded joints and weld metal in steel (Part I-general tests)
IS : 3613-1974	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels
IS : 4260-1967	Recommended practice for ultrasonic testing of welds in ferritic steel
IS : 4310-1967	Specification for weldable steel pipe fittings for marine purposes
IS : 4353-1967	Recommendations for submerged-arc welding of mild steel and low alloy steels
IS : 4559-1968	Specification for single operator rectifier type DC arc welder
IS : 4712-1968	Dimensions for forged steel socket-welding fittings
IS : 4843-1968	Code for designation of ferrous castings
IS : 4853-1968	Recommended practice for radiographic examination of fusion welded circumferential joints in steel pipes
IS : 4943-1968	Assessment of butt and fillet fusion welds in steel sheet, plate and pipe
IS : 4944-1968	Code of procedure for welding at low ambient temperatures
IS : 4972-1968	Specification for resistance spot-welding electrodes
IS : 5139-1969	Recommended procedure for repair of grey iron castings by oxy-acetylene and manual metal arc welding

IS : 5206-1969 Specification for corrosion-resisting chromium and chromium-nickel steel covered electrodes for manual metal arc welding

IS : 5462-1969 Colour code for identification of covered electrodes for metal arc welding

IS : 5511-1969 Specification for covered electrodes for manual metal arc welding of cast iron

IS : 5530-1969 Code of procedure for repair and rectification of steel castings by metal arc welding process

IS : 5687-1970 Glossary of terms relating to welding of plastics

IS : 5856-1970 Specification for corrosion and heat-resisting chromium-nickel steel solid welding rods and bare electrodes

IS : 5857-1970 Specification for nickel and nickel alloy bare solid welding rods and electrodes

IS : 5897-1970 Specification for aluminium and aluminium alloy welding rods and wires and magnesium alloy welding rods

IS : 5898-1970 Specification for copper and copper alloy bare solid welding rods and electrodes

IS : 5922-1970 Qualifying tests for welders engaged in aircraft welding

IS : 6016-1970 Specification for hose connection for welding and cutting equipment

IS : 6227-1971 Code of practice for use of metal arc welding in tubular structures

IS : 6409-1971 Code of practice for oxy-acetylene flame cutting

IS : 6419-1971 Specification for welding rods and bare electrodes for gas shielded arc welding of structural steels

IS : 6431-1971 Tolerances on dimensions of plates cut by flame

IS : 6560-1972 Specification for molybdenum and chromium—molybdenum low alloy steel welding rods and bare electrodes for gas shielded arc welding

IS : 6901-1973 Specification for pressure regulators for gas cylinders used in welding, cutting and related processes

IS : 6916-1973 Code of practice for fabrication welding of steel castings

IS : 7273-1974 Methods of testing fusion welded joints in aluminium and aluminium alloys

IS : 7280-1974 Specification for bare wire electrodes for submerged arc welding of structural steels

IS : 7303-1974 Specification for covered electrodes for surfacing of metal by manual metal arc welding

IS : 7307-1974 (Part I) Approval tests for welding procedures (fusion welding of steel)

IS : 7310-1974 (Part I) Approval tests for welders working to approved welding procedures (fusion welding of steel)

IS : 7318-1974 (Part II) Approval tests for welders when welding procedure approval is not required (TIG or MIG welding of aluminium and its alloys)

IS : 7653-1975 Specification for manual blowpipes for welding and cutting

IS : 7806-1975 Specification for ferritic and austenitic steel castings for high temperature service

IS : 8002-1976 Recommended procedure for welding of flexible PVC (Flexible Polyvinyl Chloride)

IS : 8004-1976 Recommended procedure for welding of rigid PVC (Rigid Polyvinyl Chloride)

IS : 8363-1976 Specification for bare wire electrodes for electroslag welding of steels

IS : 8484-1977 Specification for metal powders for welding electrodes

IS:SP : 12-1975 ISI handbook for gas welders