

# CONSUMABLES FOR FCAW — AN OVERVIEW

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## INTRODUCTION

Automation in welding has been a subject which is constantly engaging the attention of engineers. The objectives like reduction in manufacturing time, increased productivity, reduced manufacturing cost, less rework have ensured that more and more of welding operations are automated either fully or partially.

With growing attention towards automation, continuous welding consumables are gaining importance day by day. Not only in shop floor fabrication, these consumables are gaining importance in site fabrication also.

FCAW process, which uses continuous welding consumables, has been of great interest to fabricators and in India is fast replacing the SMAW process. With the growing interest in FCAW Process, several consumable specifications have been made available to the users, thus making the selection of the consumables for specific application possible.

However, as the range of materials, applications of FCAW are wider, the consumables are also too many in number. An understanding of the various aspects of FCAW consumables, and their intended use will be of use to the welding personnel for selecting the appropriate welding consumable. With this in mind, an attempt has been made in this paper to give an overview of the various FCAW consumables together with their specific features.

## FCAW PROCESS AND ITS ADVANTAGES

First introduced in the year 1957, FCAW combines the characteristics of SMAW, GMAW and SAW. Higher productivity as compared to SMAW and overall cost reduction have made FCAW a popular process for several applications.

Before we deal in depth with the details of the consumables, it is worthwhile understanding the advantages and disadvantages of FCAW process. Table I will give details on this.

**Table I : FCWA Process**

### Advantages

1. Good Quality, Finish, deposition rate, deposition efficiency.
2. Applicable for a range of thicknesses.
3. Visible arc - easy to use
4. Easily mechanisable
5. Self shielding versions offer good ease of operation.

### Disadvantages

1. Presently restricted to CS, LAS, SS, Ni materials only.
2. More smoke.
3. Slag must be removed.
4. Feeder, Power source to be nearer to work place.
5. Expensive equipment, and calls for maintenance.
6. The gas shielding may get disturbed in outdoor welding.

## BROAD GROUPING OF CONSUMABLES

FCAW consumables can be grouped, for a better understanding, based on the application, process and materials.

On an application basis, they can be grouped as

- **Joining consumables** – used for joining applications.
- **Hardfacing consumables** – used for hardfacing applications.

On a process basis, they can be grouped as

- **With gas shielding** – uses shielding gases like CO<sub>2</sub>, Argon
- **Without gas shielding** – (open arc process, self shielding)– Does not use any gas.

On materials basis, they can be grouped as consumables for a group of materials like carbon steels, stainless steels, nickel alloys etc.

These are only general groupings and the AWS specifications classify each consumable feature by feature and in detail. Several other grouping like rutile type, LH types, single pass types, multipass type, are possible with these classifications.

For the sake of better understanding we will be discussing two major groups viz. the joining consumables and the hard facing consumables and all other groups will be discussed within them.

## JOINING CONSUMABLES

As the group name indicates, these consumables are used for joining applications and are used for several materials. Let us understand these consumables based on various

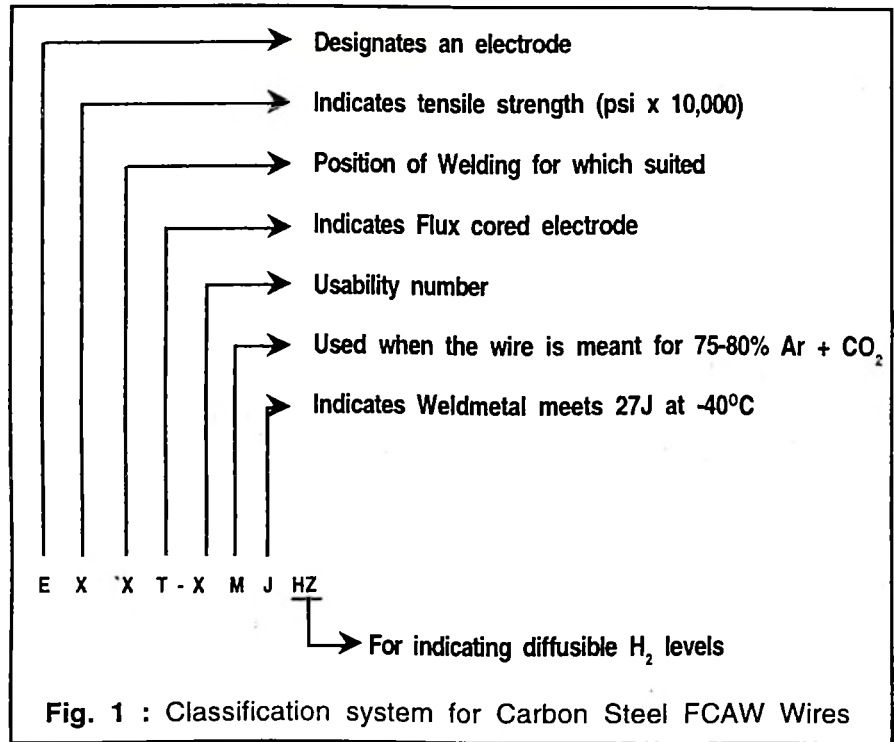


Fig. 1 : Classification system for Carbon Steel FCAW Wires

material groups. The popular material groups for which the FCAW consumables are widely available are.

- Carbon Steels.
- Low Alloy Steels.
- Stainless Steels
- Nickel Alloys

Since Ni alloys are not so popular and usage being limited, they are not being covered in this paper.

### Carbon Steel Consumables

The flux cored wires used for welding carbon steel up to -40°C are covered under the AWS specifications AWSA. 5.20. A number of grades are included in this specification to cover a range of application and property requirements. The general basis of classification is indicated in Fig. 1,

which takes into account a number of variables while classifying the wires. It can be observed that apart from the mechanical, welding positional indications, the usability and performance capabilities gain lot of importance as they distinguish each wire from another. Factors like suitability for single pass, multipass, polarity, arc transfer characteristics, penetration, shielding requirements are covered in this number. Since many welding applications call for specific requirements or attention to specific features, a variety of wires have been made to suit each application requirement.

Table II will give in a concise form the specific use of each grade of wire at a glance. Depending on the job requirement a choice can be made to achieve best results.

### Low Alloy Steel Consumables

These are covered under the AWS classification AWS A 5.29. Unlike the specification for carbon steels, which deals with a variety of types of wires without much compositional variations, this specification deals with only four types of wires with lot of chemical, mechanical property variations. The classification system however remains similar with necessary addition for indicating the alloy type. Fig. 2 will bring out the basis of the classification system and Table III will bring out the different types in this specification.

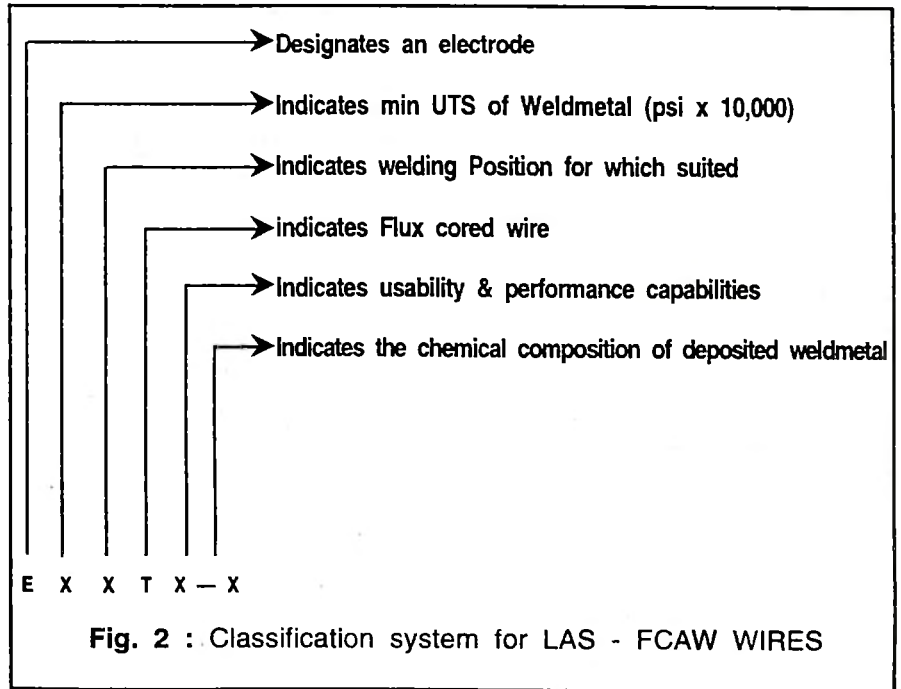
However, the major emphasis is on the chemical composition and mechanical properties. The various alloys covered under this specification and their indicative alphabets are given below :

A.	Carbon-Molybdenum Steel
B.	Cr-Mo Steels
Ni	Ni-Steels
D	Mn-Mo Steels
K	Mn-Ni-Cr-Mo-C alloyed Steels

Depending on the composition of the base material a suitable group, type of wire can be selected.

### Stainless Steel Consumables

These consumables are covered under the AWS classification A 5.22. Similar to the low alloy steel specification, emphasis is once again on the compositional variation



and only a few types are classified. The classification system is shown in Fig. 3. The classification system in general follows the AISI numbering system.

The various types of wires covered under this classification are given below :

Type	Shielding	Polarity
TX-1	CO <sub>2</sub>	DCEP
TX-3	None	DCEP
TX-4	75-80% Ar+CO <sub>2</sub>	DCEP

Based on the chemistry a host of wires are covered under this specification to suit each base material and application. Both compositional, property require-

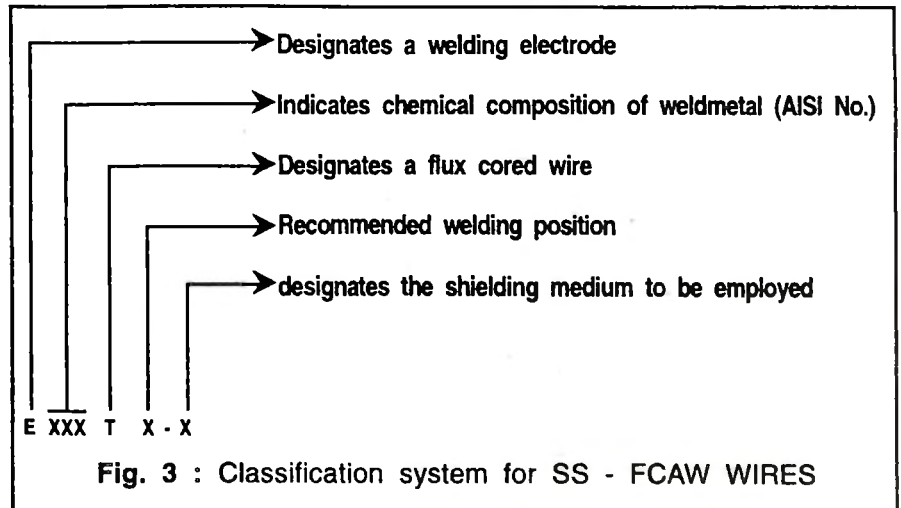


Table II

**MILD STEEL FCAW ELECTRODES**

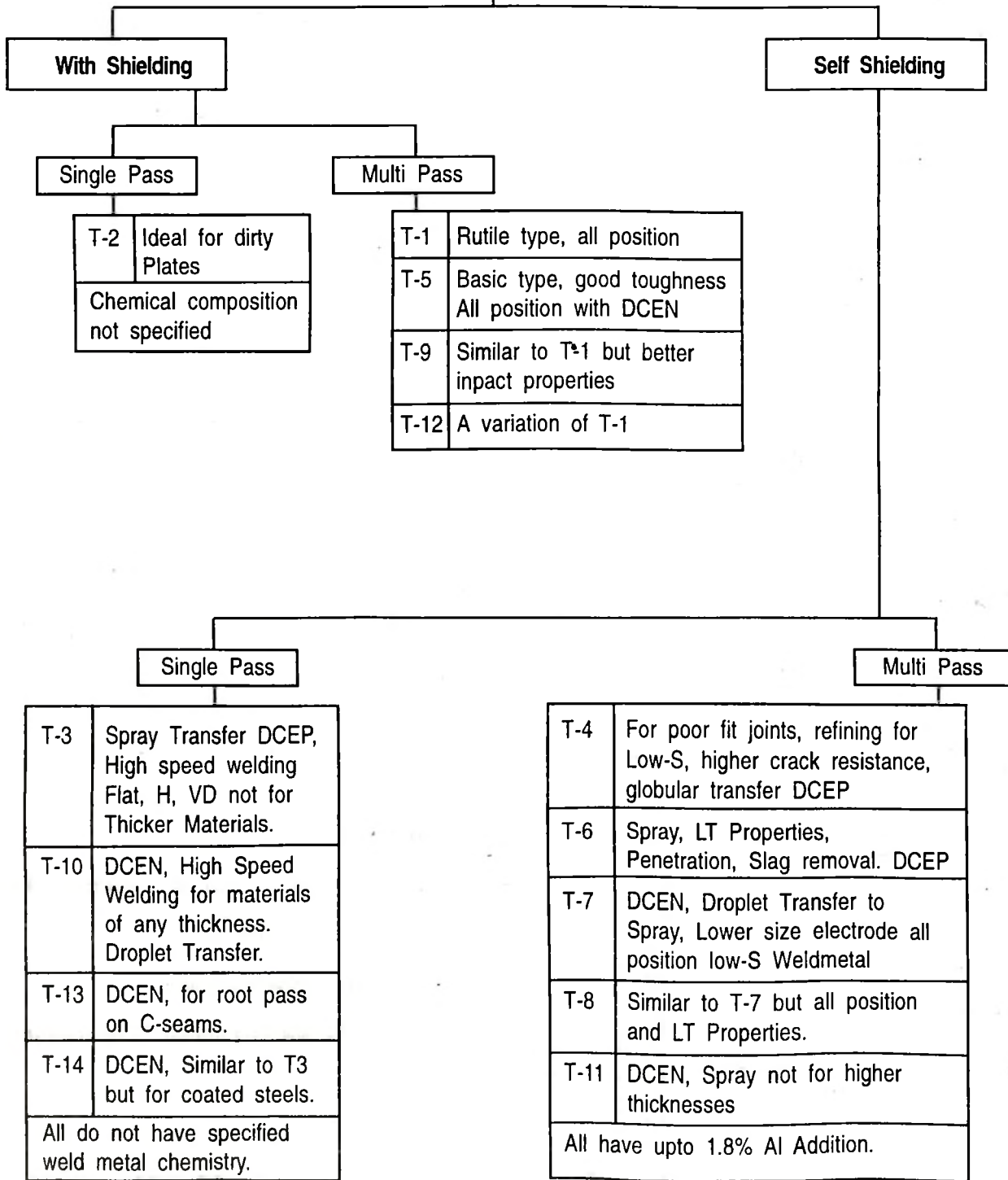


Table III

**LOW ALLOY STEEL FCAW ELECTRODES**

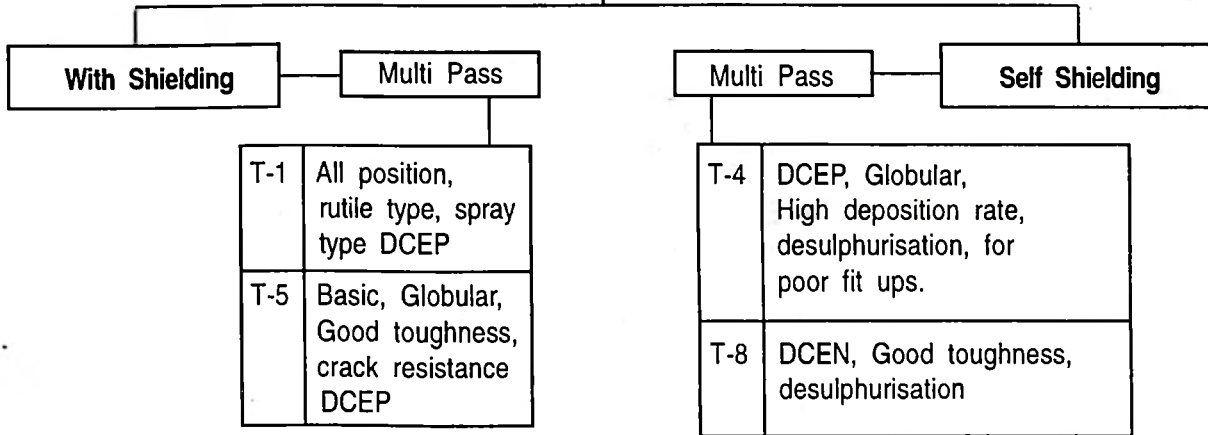


Table IV : Typical hard facing wire composition & properties

Sl. No.	Type	Weldmetal Chemistry (%)	Hardness (Typical)	Applications
1.	Openarc	0.7C - 14Mn -2.3Cr 0.2Ni-0.8Si	20 HRC (as welded)	Work hardening deposit for Mn Steel Applications to resist Impact.
2.	Openarc	0.4C-14Cr-14Mn-0.7Si	24 HRC (as welded)	Work hardening deposit for resisting severe impact loads.
3.	Openarc	0.15C-1.5Mn-1.5Cr -0.6Si	35 HRC	Air hardening deposit for resisting rolling, frictional wear.
4.	Openarc	0.55C-6.3Cr-0.5Mo -0.75V	55 HRC	Air hardening deposit for resisting abrasion and impact.
5.	Openarc	5C-25Cr	60 HRC	Cr-Carbide deposit for resisting severe abrasion.
6.	Openarc	5C-21Cr-6.3Nb	60 HRC	Complex carbide deposit for resisting abrasion.
7.	Openarc	5C-22Cr-0.8V- 6.5Nb-2W-6Mo	65 HRC	Complex carbide deposit for resisting severe abrasion at higher higher temperature.

ments along with operational requirements can be used to select the appropriate wire.

### HARDFACING CONSUMABLES

It is here one can observe a variety of consumables to suit every requirement. The operating characteristics, chemical, mechanical property variation are so wide as to cover a wide ranging application in hardfacing, maintenance and repair. However, the basic categories of wires remain the same (i.e.) shielded and self shielding type. In most of the occasions self shielding types are preferred. There are no specifications and no AWS classification systems and one has to choose the wire depending on the base material and the service requirements. A typical list of some of the consumables is given in Table IV for reference.

### GAS SHIELDING (VS) SELF SHIELDING

In the earlier paragraphs we have been discussing about two types of FCAW wires, self shielded open arc and the other gas shielded. It is necessary to understand the features of both types of wires so that a proper choice can be made wherever feasible. The following details will be of relevance in this respect.

GAS SHIELDED	OPEN ARC
1. Uses a shielding.	1. No shielding gas.
2. Does not tolerate air currents. ideal for shop floor.	2. Tolerates stronger air current; Ideal for field work.
3. Shorter Electrode Extension.	3. Long Electrode Extension Possibility of higher deposition rates.
4. Weld bead narrow and deep penetrating.	4. Well bead is narrow and shallow.

### STEPS IN SELECTING FCAW CONSUMABLES

Having understood the range of FCAW consumables let us now list out the steps involved in selecting a consumable.

#### For joining application

- a. Identify the base material composition & properties required for the weld metal.
- b. Identify the base material group (i.e.) CS/LAS/SS etc.
- c. Choose the similar group of consumables and in most applications, either matching composition or/and mechanical properties will be required.
- d. Depending on the welding requirements choose the sub classification and select the consumable.

#### For hard facing applications

- a. Determine the base material composition & service condition requirements.
- b. Analyse the available consumable chemistries, properties and

match them with the requirements.

- c. In some cases, depending on base material a buffer layer may be required.
- d. Select the consumable and decide the procedure.

These steps are only guide lines and in specific cases some more detailed study, analysis may be required to select the appropriate consumable.

### CONCLUSION

The FCAW process is a potential process and its usage is covering a vast number of applications today, with growing interest in automation. FCAW will continue to enjoy this attention and more and more consumables will be developed to suit newer materials and applications. At present the material groups CS, LAS and SS are popularly welded using FCAW process and an understanding of the consumables available for these material with respect to their feature, properties will enable easier selection and proper usage.