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SUPER & ULTRA-SUPER CRITICAL BOILERS – What the buzz is all about !

Introduction:

Generation of power in the most efficient way has been engaging the attention of power industries for quite some time now. Selection of proper steam generation technology is a critical requirement to be considered in the basic design of a new project. The emergence of super critical boilers (SCB) and ultra super critical boilers (USCB) is a major step in this direction. With the increased thrust on power generation in India, a number of boilers of these types are planned to be constructed in the near future. Welding is a critical activity in the construction of these boilers and a good understanding of the materials that would be used as well as their welding related aspects will be highly useful in producing quality welds that will perform well in service. Some information on all these aspects, including types and classification of welding consumables for these applications, is described in this note.

What are a super critical boiler and ultra supercritical boiler?

All boilers operate at a particular temperature and pressure. But

Product Update

CHAMP MULTI 400 (FCAW)
CHAMP MULTI 400

- The new world class inverter based multi process outfit with synergic operation

CHAMP 400

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some boilers operate above a critical temperature. The importance and meaning of critical temperature is best explained by the following example: When water is heated it starts boiling at 100°C. But during boiling its temperature does not rise further. The heat applied goes to the latent heat. However this is at normal pressure. As the pressure is increased, boiling takes place at higher temperature but the latent heat reduces. The following table will illustrate this:

PRESSURE-BAR	WATER BOILS AT °C	LATENT HEAT KJ/KG
NORMAL	100	2256
100	311	1318
200	366	584
220.6	374	0

It can be observed that after a particular pressure the latent heat is zero-the water becomes steam immediately. Boilers operating above this pressure and temperature are called Super-Critical boilers and Ultra Super Critical boilers. The table given below gives the typical operating conditions (not boiling temperatures) of sub critical, super critical and ultra super critical boilers.

TYPE OF BOILER	PRESSURE- BAR	TEMPERATURE °C
SUB CRITICAL	170	540
SUB CRITICAL	230-265	540-620
ULTRA SUB CRITICAL	>300	700-720

Is it a newly discovered theory?

No. This fact was known in the earlier days also but lack of design knowledge, lack of understanding of materials and non-availability of suitable materials prevented reaching these temperatures and pressures in the boilers.

What are the advantages of these boilers?

Use of high pressures and temperatures give these boilers the

advantages described below.

1. Increased efficiency
2. Lower operating costs
3. Lesser dependency on welder skill to set the parameters
4. Lower emission levels of CO_2 and SO_2

What are the properties required for materials for these boilers?

Like for all high temperature applications, steels used in these boilers require

1. Excellent creep strength, creep ductility
2. Oxidation resistance
3. Corrosion resistance
4. Weld ability

Normally Cr-Mo steels of the type, 1Cr-0.5Mo, 2Cr-1Mo, 5Cr-0.5Mo, and 9Cr-1Mo are used in sub critical or conventional boilers. For SCB and USCB, additions of V, W, Ni, Nb, Ti, B, and N are done in the above basic grades at different levels and in different combinations to get the desired properties. Please see the chart below for major alloying elements in steels used for different types of boilers.

Grade	Major Alloying Elements
P11-T11	1Cr-0.5Mo
P22V-T22V	2.25Cr-1Mo-0.3V
P22-T22	2.25Cr-1Mo
P23-T23	2.25Cr-1.55W-0.02V-0.06Nb; Mo<0.3; N<0.010
P24-T24	2.25Cr-1Mo-0.24V;B 15-17ppm; Ti 0.05-0.10; B< 0.010
P502-T502	5Cr-0.5Mo
P9-T9	9Cr-1Mo
P91-T91	9Cr-1Mo-0.22V-0.08Nb; N 30-70ppm
P911-T911	9Cr-1Mo-0.25Ni-0.22V-1.05W-0.08Nb; N 0.05-0.09

P92-T92	9Cr-1Mo-0.23V-1.55W-0.08Nb; N 0.03-0.07; B 0.001-0.006

Welding considerations for these materials

The welding considerations can be summarized as given below

1. All these materials require preheating, post heating and post weld heat treatment
2. All materials are to be welded with LH electrodes, processes
3. All processes like SMAW, GAW, GMAW, FCAW, SAW can be used
4. Many welded joints may have to undergo prolonged heat treatments and/or repeated heat treatments because of which the weld metals may have to be tested for prolonged hours of soaking
5. Some weld metals especially the 2Cr types should have resistance to temper embrittlement. This can be achieved by controlling the impurity elements and by subjecting the weld metal to a step cooling heat treatment
6. Non-synthetic types are preferred especially for the higher alloy types

ADOR WELDING LTD. RANGE OF CONSUMABLES FOR ALLOY STEELS USED IN BOILERS

AWL produces a wide range of welding consumables to suit these materials.

Grade	Remarks	SMAW	GTAW	GMAW	SAW	FCAW
			TIGFIL	AUTOMIG	AUTOMELT	AUTOMIG FC
P11		CROMOTEN	80SB2	80SB2	EB2+B25 plus	81T1B2
P11	PHT	CROMOTEN				

		S PLUS				
P22		CROMOTEN C	90SB3	90SB3	EB3+B25 plus	91T1B3
P22	PHT	CROMOTEN C PHT				
P22	STC	CROMTEN 2 STC				
P5		CROMOTEN D	80SB6	80SB6		
P9		CROMOTEN 9	80SB8	80SB8		
P91		CROMOTEN 9M SPL*	90SB9	90SB9		

PHT = PROLONGED HEAT TREATMENT
STC = STEP COOLING HEAT TREATMENT
* NON-SYNTHETIC TYPE

1. GUARANTEED CONSISTENT PROPERTIES
2. CONSUMABLES CAN BE DESIGNED AS PER YOUR SPECIFICATION REQUIREMENTS

Please click on the name of consumable described above to view chemical and mechanical properties of its weld metal.

Please contact us at cmo@adorians.com for more details on this subject and for help in selecting the right consumables for these applications.


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