15CDV6, 12CRMOV6-9, 14CRMOV6-9, 15CRMOV5-10

15CDV6 is a low-alloy chromium-molybdenum-vanadium steel commonly used for manufacturing high-strength and high-temperature application components, such as parts in the aerospace industry and automotive engine components. This material possesses excellent strength and heat resistance, making it suitable for environments requiring the ability to withstand high temperatures and significant loads.

Chemical Composition

Grade	Chemical composition WT %									
	C	Mn	Si	P	S	Cr	Mo	V	Ni	Cu
AIR 9160 15CDV6	0.12 - 0.18	0.8 - 1.1	max 0.20	max 0.020	max 0.015	1.25 - 1.50	0.8 - 1.0	0.2 - 0.3	-	-
12CrMoV6-9, 1.7734	0.12 - 0.18	0.8 - 1.1	max 0.20	max 0.020	max 0.015	1.25 - 1.50	0.8 - 1.0	0.2 - 0.3	-	-
14CrMoV6-9, 1.7735	0.11 - 0.17	0.8 - 1.0	max 0.25	max 0.020	max 0.015	1.25 - 1.50	0.8 - 1.0	0.2 - 0.3	-	-
15CrMoV5-9, 1.8521	0.13 - 0.18	0.8 - 1.1	max 0.4	max 0.025	max 0.030	1.20 - 1.50	0.8 - 1.1	0.2 - 0.3	-	-
15CrMoV5-10, 1.7745	0.10 - 0.16	0.4 - 0.9	0.15 - 0.35	max 0.025	max 0.015	1.10 - 1.40	0.9 - 1.1	0.20 - 0.35	max 0.25	max 0.25

Mechanical Properties

15CDV6 Heat-treated to AIR 9160C

Mechanical properties - bars			
Size	<16mm T980	16 - 25mm T1080	25 - 70mm T1080
m (MPa)	980 - 1180	1080 - 1280	1080 - 1280
e (MPa)	>780	>930	>930
Elongation A (%)	>12	>10	>10
Hardness (HB)	291 - 350	321 - 380	321 - 380
Impact strenght KCU	>6	>8	>6

Mechanical properties - sheets		
size	<2mm T980	2 - 20mm T1080
m (MPa)	980 - 1180	1080 - 1280
p0,2 (MPa)	>780	>930
Hardness (HRB/HRC)	>29	>33

Mechanical properties - tubes		
size	<2mm T980	2 - 20mm T1080
m (MPa)	980 - 1180	1080 - 1280
p0,2 (MPa)	>780	>930
Elongation A (%)	>10	>10
Hardness (HRB/HRC)	>29	>33

- 1.7734.2- the softened state
-
- 1.7734.4
  - Tensile strength, Rm =>700 MPa
  - Yield point, Re =>550 MPa
  - Elongation, A = > 13%
-
- 1.7734.5
  - Tensile strength, Rm = 980 - 1180 MPa
  - Yield point, Re => MPa
  - Elongation, A = > 11%
-
- 1.7734.6
  - Tensile strength, Rm = 1080 - 1250 MPa
  - Yield point, Re => MPa
  - Elongation, A = > 13%

Physical Properties

Sure, here are some physical properties of 15CDV6 steel:

1. **Density**: The density of 15CDV6 steel is typically around 7.85 g/cm³.

2. **Hardness**: Depending on the specific heat treatment, 15CDV6 steel can exhibit varying hardness levels,

typically falling within the range of 200 to 300 HB (Brinell hardness).

3. **Melting Point**: The melting point of 15CDV6 steel is approximately 1420-1460°C (2590-2660°F).

4. **Thermal Conductivity**: The thermal conductivity of 15CDV6 steel is around 41 W/(m·K), which means it conducts heat relatively well.

5. **Electrical Conductivity**: Like most metals, 15CDV6 steel has a relatively high electrical conductivity.

6. **Magnetic Properties**: 15CDV6 steel is generally ferromagnetic, meaning it can be attracted to magnets and can be magnetized itself.

These physical properties can vary slightly depending on factors such as the exact composition of the steel and the specific manufacturing processes used.

Heat Treatment

The heat treatment process for 15CDV6 steel typically involves a sequence of heating and cooling steps to achieve desired mechanical properties. Common heat treatments for 15CDV6 include:

1. **Annealing**: Heating the steel to a temperature between 850°C to 900°C (1560°F to 1650°F) and holding it at that temperature for a sufficient time followed by slow cooling in the furnace or air. Annealing relieves internal stresses and softens the material for further processing.

2. **Normalizing**: Heating the steel to a temperature between 890°C to 940°C (1630°F to 1720°F) and then air cooling. Normalizing refines the grain structure and improves the mechanical properties of the steel.

3. **Quenching and Tempering**: After heating the steel to a temperature between 850°C to 900°C (1560°F to 1650°F), it is rapidly cooled (quenched) in a suitable medium such as oil or water to harden it. Subsequently, the hardened steel is reheated to a lower temperature, typically between 550°C to 600°C (1020°F to 1110°F), and then air cooled (tempered). This process increases the hardness and strength of the steel while also improving its toughness and ductility.

4. **Stress Relieving**: Heating the steel to a temperature between 550°C to 650°C (1020°F to 1200°F) and holding it at that temperature for a sufficient time followed by slow cooling. Stress relieving helps to reduce residual stresses in the material, which can improve dimensional stability and reduce the risk of distortion during subsequent machining or welding processes.

The specific heat treatment process chosen for 15CDV6 steel depends on the desired mechanical properties and the intended application of the final product.

Welding Properties

Welding 15CDV6 steel requires careful consideration of its chemical composition and mechanical properties to ensure a successful weld with desired strength and integrity. Here are some key points to consider when welding 15CDV6 steel:

1. **Preparation**: Properly clean the surfaces to be welded to remove any contaminants, such as oil, grease, or dirt, which can negatively affect the quality of the weld.

2. **Welding Method**: Common welding methods for 15CDV6 steel include gas tungsten arc welding (GTAW or TIG), gas metal arc welding (GMAW or MIG/MAG), and shielded metal arc welding (SMAW or stick). Each method has its advantages and limitations, so choose the most suitable method based on the specific application and requirements.

3. **Filler Material**: Select a filler material that is compatible with 15CDV6 steel and matches its mechanical properties. Common filler materials for welding 15CDV6 steel include low-alloy steel electrodes or wires with similar composition to the base metal.

4. **Preheat and Interpass Temperature**: Preheating the base metal to a specific temperature before welding can help reduce the risk of cracking and improve weld quality. Additionally, maintaining an appropriate interpass temperature during welding can help control the cooling rate and minimize the formation of brittle microstructures.

5. **Welding Parameters**: Adjust welding parameters such as voltage, current, travel speed, and shielding gas flow rate to achieve optimal weld bead geometry and penetration while minimizing the risk of defects such as porosity, lack of fusion, or excessive spatter.

6. **Post-Weld Heat Treatment (PWHT)**: Depending on the welding process and specific requirements, a post-weld heat treatment may be necessary to relieve residual stresses and improve the mechanical properties of the welded joint.

7. **Welding Position and Joint Design**: Consider the welding position and joint design when planning the welding process. Ensure adequate accessibility and proper fit-up to facilitate welding and achieve desired weld quality.

8. **Welding Procedure Qualification**: Develop and qualify welding procedures in accordance with applicable codes, standards, and specifications to ensure the integrity and reliability of the welded joints.

By following these guidelines and best practices, it is possible to achieve high-quality welds when welding 15CDV6 steel, meeting the performance and integrity requirements for various industrial applications.

Machining Properties

Machining 15CDV6 steel requires consideration of its specific composition and mechanical properties to achieve accurate and efficient results. Here are some key points to consider when machining 15CDV6 steel:1. **Tool Selection**: Choose cutting tools that are appropriate for machining medium to high-strength steels. Carbide or high-speed steel (HSS) tools with suitable coatings (such as TiN, TiCN, or TiAlN) are commonly used for machining 15CDV6 steel.2. **Cutting Speed**: Select the appropriate cutting speed based on the type of cutting operation (turning, milling, drilling, etc.), tool material, and workpiece material. Start with conservative cutting speeds and gradually increase them while monitoring tool wear and workpiece surface finish.3. **Feed Rate**: Adjust the feed rate to achieve optimal chip formation and prevent excessive tool wear. Higher feed rates can improve productivity, but excessive feed rates may result in poor surface finish or tool failure.4. **Depth of Cut**: Determine the appropriate depth of cut based on the tool diameter, workpiece material, and machining conditions. Avoid excessive depths of cut, as they can increase cutting forces and heat generation, leading to reduced tool life and poor surface finish.5. **Coolant Use**: Use coolant or cutting fluid to dissipate heat and lubricate the cutting tool-workpiece interface, reducing friction and tool wear. Flood coolant or mist coolant systems are commonly used during machining operations.6. **Workpiece Fixturing**: Secure the workpiece properly to minimize vibrations and ensure dimensional accuracy during machining. Use appropriate clamping devices or fixtures to hold the workpiece securely in place.7. **Tool Geometry**: Ensure that cutting tools have the correct geometry, including rake angle, clearance angle, and cutting edge geometry, to optimize chip formation and minimize cutting forces.8. **Tool Wear Monitoring**: Regularly inspect cutting tools for signs of wear and damage, such as flank wear, chipping, or built-up edge. Replace worn or damaged tools promptly to maintain machining accuracy and productivity.9. **Chip Control**: Manage chip formation and evacuation to prevent chip recutting and tool damage. Use appropriate chip breakers, tool coatings, or chip evacuation systems to control chip flow and improve machining efficiency.By applying these guidelines and best practices, it is possible to achieve efficient and accurate machining of 15CDV6 steel, meeting the requirements of various industrial applications.