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Analysis of erosion-corrosion resistance and Various Application in domestic and Industrial field of Stainless Steel Grade 304

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Abstract—
Stainless steel 304 is represent a excellent corrosion resistance and a large family of alloys and end uses. These steels enjoy a wide range of applications because of good corrosion resistance, good high and low temperature strength and ductility, and excellent weldability. It has been previously demonstrated that Stainless steel Grade 304 can improve the resistance of erosion and corrosion. All the analysis demonstrated that chromium effectively improved properties of the passive film, including corrosion resistance, mechanical behavior and the film stability, resulting in enhanced resistance to corrosion-erosion. The corrosion resistance of stainless steel is attributed to the formation of passive film, which protects the material from continuous corrosion attack. However, when subjected to the attack combining corrosion and erosion, the passive film could be damaged by solid particle impingement, resulting in exposure of bare metal surface to the corrosive medium and thus increasing the corrosion-erosion rate. But the main limitation of stainless steel is erosion due to which the nozzle needs to be replaced frequently. Hard facing is commonly applied method to improve the surface properties of components.

Keywords—

SS304; Erosion-corrosion Resistance

I. INTRODUCTION

Stainless steels or, more precisely, corrosion-resisting steels are a family of iron-base alloys having excellent resistance to corrosion. These steels do not rust and strongly resist attack by a great many liquids, gases, and chemicals. Many of the stainless steels have good low-temperature toughness and ductility. Most of them exhibit good strength properties and resistance to scaling at high temperatures. All stainless steels contain iron as the main element and chromium in amounts ranging from about 11% to

30%. Chromium provides the basic corrosion resistance to stainless steels.(1) AISI 304 stainless steel (AISI 304 SS) is standard construction material for many industrial applications owing to its excellent corrosion resistance, mechanical strength and good weldability [2, 3]. However, due to rising costs of Ni, interest in low-Ni or Ni-free austenitic stainless steels (Cr– Mn–Ni ASS or Cr–Mn ASS) is increasing [4]. These steels in general are termed as 200 series ASS and account for more than 10 % of total stainless steel production [5]. Stainless steel is widely used in oil production, chemical, and mining industries to make hydro-turbines, pumps and pipelines, because of its combination of good corrosion resistance and mechanical properties [6, 7]. Type 304 is the most versatile and widely used stainless steel. A single-phase austenitic structure is preferred in 18% Cr–8% Ni stainless steel because of its superior mechanical properties and corrosion resistance. Previously published works have assessed the performance of 18% Cr–8% Ni SS with Si (ferrite stabilizer) additions, which may be added to increase corrosion resistance, at levels low enough to maintain an austenitic structure [8].

II. BACKGROUND

Grade 304 is the standard "18/8" stainless; it is the most versatile and most widely used stainless steel, available in a wider range of products, forms and finishes than any other. It has excellent forming and welding characteristics. The balanced austenitic structure of Grade 304 enables it to be severely deep drawn without intermediate annealing, which has made this grade dominant in the manufacture of drawn stainless parts such as sinks, hollow-ware and saucepans Grade 304 is readily brake or roll formed into a variety of components for applications in the industrial, architectural, and transportation fields.

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Grade 304 also has outstanding welding characteristics.

These alloys may be considered for a wide variety of Applications where one or more of the following properties are important:

- Resistance to corrosion
- Prevention of product contamination
- Resistance to oxidation
- Ease of fabrication
- Excellent formability
- Beauty of appearance
- Ease of cleaning
- High strength with low weight
- Good strength and toughness at cryogenic temperatures
- Ready availability of a wide range of product forms

Each alloy represents an excellent combination of corrosion resistance and fabricability. This combination of properties is the reason for the extensive use of these alloys which represent nearly one half of the total U.S. stainless steel production. The 18-8 stainless steels, principally Alloys 304, 304L, and 304H, are available in a wide range of product forms including sheet, strip, and plate.

Stainless steel 304 are categorized into three grades 304, Grade304H and 304L respectively

304 Stainless Steel

Stainless steel 304 is an austenitic grade that can be severely deep drawn. This property has resulted in 304 being the dominant grade used in applications like sinks and saucepans.

304L Stainless Steel

Type 304L is the low carbon version of Stainless steel 304. It is used in heavy gauge components for improved weldability.

304H Stainless Steel

Type 304H is the high carbon content variant, is also available for use at high temperatures. It can applicable for high temperature application.

The chemical composition SS304 are shown in TABLE I

TABLE II

Chemical Composition of Stainless Steel 304

%	304	304L	304H
C	0-0.07	0-0.03	0.04-1
Mn	0-2.0	0-2.0	0-2.0
Si	0-1	0-1	0-1
P	0-0.05	0-0.05	0-0.05
S	0-0.02	0-0.02	0-0.02
Cr	17.5-19.5	17.5-19.5	17.5-19.5
Ni	8-10.5	8-10.5	8-10.5
Fe	Balance	Balance	Balance

III. EROSION-CORROSION ANALYSIS:

Chromium (Cr) - gives stainless steel its stainless quality. Increases response to heat treatments and depth of hardness. In combination with nickel, greatly increases corrosion and oxidation resistance. Also increases toughness, tensile strength, and resistance to wear.

A. EROSION CORROSION OF STAINLESS STEEL 304:

Stainless steel 304 has excellent corrosion resistance in a wide variety of environments and when in contact with different corrosive media. Pitting and crevice corrosion can occur in environments containing chlorides. Stress corrosion cracking can occur at temperatures over 60°C. Corrosion is defined as the destruction or deterioration of material because of reaction with its environment. Some insist that the definition should be restricted to metals, but often the corrosion engineers must consider both metals and nonmetals for solution of a any problem [9, 12]. The corrosion resistance of the martensitic stainless steels is lower than that of the austenitic steels. These alloys are normally used in atmospheric corrosive applications.
It is well known that the erosion behaviour of the same material will vary depending on the type of erosion rig used and also with the nature of the erodent used (erodent shape, size and hardness). Thus the evaluation of the relative erosion resistance of various types of stainless steels is possible only if they can be tested simultaneously in the same rig and under identical conditions.

B. OXIDATION RESISTANCE

The maximum temperature to which type 304 can be exposed continuously without appreciable scaling is about 1650^0F (899^0C) for intermittent cyclic exposure, the maximum exposure temperature is about 1500^0F (816 ^{0}C).

C. HOT CORROSION

High-temperature corrosion is chemical deterioration of a material (typically a metal) as a result of heating. This non-galvanic form of corrosion can occur when a metal is subjected to a hot atmosphere containing oxygen, sulphur or other compounds capable of oxidizing (or assisting the oxidation of) the material concerned. Oxidation is a type of corrosion involving the reaction between a metal and air or oxygen at high temperature in the absence of water or an aqueous phase. It is also called dry-corrosion. The rate of oxidation of a metal at high temperature depends on the nature of the oxide layer that forms on the surface of metal. Metals and alloys may experience accelerated oxidation when their surfaces are coated by a thin film of fused salt in an oxidizing gas. This mode of attack is called hot corrosion.

IV. DOMESTIC AND INDUSTRIAL APPLICATION

Austenitic stainless steel are widely used in cutlery, sink, tubing, dairy food and pharmaceutical equipment as well as in springs, nut bolt and screw, due to their high strength and high corrosion and oxidation resistance. AISI 304 STAINLESS STEEEL finds its application in aircraft fitting aerospace components such as bushing shaft, valves special screw, cryogenic vessel and component for severe chemical environments. It is also being used for welded construction in aerospace structure components [13].

The Alloys 304, 304L, and 304H austenitic stainless steels provide useful resistance to corrosion on a wide range of moderately oxidizing to moderately reducing environments. The alloys are used widely in equipment and utensils for processing and handling of food, beverages, and dairy products. Heat exchangers, piping, tanks, and other process equipment in contact with fresh water also utilize these alloys. Manganese steels are not harden able by heat treatment and are nonmagnetic in the annealed condition. They may become slightly magnetic when cold worked or welded. Austenitic stainless steels (which contain 18% Cr–8% Ni) are engineering materials widely used in many branches of industry, especially in the food and beverage manufacturing and processing sector, due to their attractive combination of good mechanical properties, formability, and corrosion resistance. Their corrosion resistance is afforded by a thin Cr_2O_3 surface film (typically 1–3 nm thick), known as passive film, which has self-healing capability in a wide variety of environments.

Applications of Stainless Steel 304

Stainless steel 304 is typically used in:

- Sinks and splashbacks
- Saucepans
- Cutlery and flatware
- Architectural panelling
- Sanitaryware and troughs
- Tubing
- Brewery, dairy, food and pharmaceutical production equipment
- Springs, nuts, bolts and screws

Cost

The consideration of cost in selecting materials for high temperature service must reflect not only the initial cost of the equipment and downtime as well. Designers should not rule out the more highly alloyed, more-costly materials if a premature failure could result in shutting down the entire plant and loss of valuable production. Designers should consider the possibility of using different steels within the same application.

V. CONCLUSION

Corrosion Resistance of stainless steel Grade 304 is Excellence after and before heat treatment. This study we conclude the Stainless steel 304 behavior in high temperature and high pressure condition its corrosive resistance is high. Stainless steel 304 cannot be hardened by heat treatment process but harden rapidly cold work and or non magnetic and Stainless steel can pose special Corrosion challenges, since its passivation behaviour relies on the presence of a major alloying component (chromium, at least 11.5%).

Finally we conclude the analysis of Stainless steels improve the reliability and efficiency. its can work on high corrosive atmosphere and Their performance has already been demonstrated. making them the material of choice for Used as many Domestic and Industry processing equipment.

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