

Traits and Characteristics of Eco Sustainable Stainless Steel 304

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Abstract:- Steel is one of the most eco-friendly and unique sustainable materials because of their endless recyclable properties. Once it is made it can be used as steel forever. There is relatively little energy used to produce it and their wastage is produced reusable, some steel industry/mills only use scrap to provide new steel. Steel can be infinitely recycled, so the investment in producing it is not wasted and can be capitalized on by future generations. The groups of stainless steel are playing a vital role in energy evolution and sustainable design. Ultimately, the foremost environmentally friendly materials stainless steel grade 304 is the preferred material for green building all over the world. Their impact on the environment is minimal when compared to other materials and life impact reduces significantly because of highly use and recyclable properties. The SS304 is corrosion resistant and durable, recapture rates and has higher cycled content that provides long service life, and reduces resource use.

Keywords:- Stainless Steel, Recycle, Corrosion Resistant and Service Life.

I. INTRODUCTION

Stainless steel represents large family of alloy and endless uses of engineering materials. Stainless steel is 100% recyclable and does not lose any physical properties within the process. There are several applications of Stainless Steel (SS), the most common applications include: construction, it has excellent corrosion resistance, strength in combination with good mechanical properties, manufacturing characteristics, and malleability, low maintenance, durable curtain walls and roof allow the construction attractive. Stainless steel is an extremely versatile material that offers economically viable alternative for the designer. Since stainless steel is infinitely recyclable, the capital spent on producing it is never lost and can be used to benefit other generations. Stainless steel is a substance that is utilised rather than consumed. It is one of the materials that do not lose its properties when recycled. The industry believes that sustainable development must meet the requirements of this without compromising the flexibility of future generations to satisfy their own needs. Steel is important to the technologies and solutions that meet society's everyday needs, now and the future. Steel application is central to our infrastructure, housing, current transport systems, manufacturing, agriculture, water, and

energy supply. It is also critical to the sectors and technologies which will enable.

➤ Background

The environmental friendliness of the stainless-steel sector has been well established. Because stainless steel can be methodically separated and enter the recycling system, products composed of stainless steel like wire or banding will never become worthless at the end of their useful lives. The life cycle of stainless steel does not include a separate stage for production and recycling. Recycling is viable when applied to stainless steel because it contains raw resources like iron, chromium, and nickel. As a result, recycling stainless steel is done all over the world.

➤ Sustainability of Stainless Steel

Steel is one of the most eco-friendly interior design materials because:

- Due to its strength, do not need a lot to do the job.
- It is endlessly recyclable; some steel mills only use scrap to produce new steel.
- There is relatively little energy used to produce it.
- The waste produces are reusable.
- It is not toxic to humans or the environment.

II. ENVIRONMENTAL ASPECTS OF STAINLESS STEEL

Environmental concerns are crucial to maintaining and saving our planet. Stainless steel has great potential to become a reusable and environmentally friendly material:

➤ Recycling and Service Life of Stainless Steel

Theoretically 100% recyclable, stainless steel is an ideal environmental performer and outperforms several other materials in terms of service life. Products made of stainless steel are made to last a long time, frequently several decades. This aspect is the main justification for choosing stainless steel Grade 304 in the first place. But there will come a point when the stainless steel's useful life is over. The end of life may also occur because of technological redundancy, the product being replaced by more effective technology, changes in fashion, or the product's design having reached the end of its useful life. Even though the end of life is reached, this doesn't mean that stainless steel isn't useful as a recyclable product. The most

alloying elements of stainless steel (nickel, chromium, and molybdenum) are all highly valuable content and its easily separated from other materials and recovered.

➤ *Stainless Steel Improves Modern-Day Life*

Stainless steel has many social and environmental benefits. Stainless steel products enable us to guide a healthier life and are cleaner for the environment also. Although it is impossible to demonstrate all areas where it beneficial, below are several examples where stainless steel is used.

• *Improvements to Air Quality*

Air pollution is a big problem in now a day, where air emission is of such high importance in world. The greater influence of cars on the road, planes in the air and production factories, all are created problem. The impact of rising "greenhouse gas" levels on climate change is likely the most contentious example, although "acid rain"-causing pollutants are also important to consider. New catalytic converters frequently use stainless steel (SS 304) for the storing and transportation of catalytic materials to help mitigate this issue. The most recent variants are far stronger, lighter, and more energy efficient than classic ceramic versions. Stainless steel was chosen as the material because catalytic chemicals are frequently quite corrosive and active in high temperature environments. These stainless-steel converters aid in reducing pollution from several sources, including buses, trains, forklifts, trucks, generator sets, and mining equipment.

“Diesel filters can filter 85% of soot particles and 95% of black smoke”. Diesel filters are made to remove soot and smoke from a diesel engine's exhaust gas. Modern models can have up to 90% stainless steel in them. Diesel filters can remove 95% of the black smoke and 85% of the soot particles from the gas produced. The most straightforward alternative for the filter is stainless steel because of its outstanding temperature resistance, manufacturability, and cost effectiveness.

• *Reduction in the use of Fossil Fuels*

We are all aware of the significance of preserving the global supply of fossil fuels. The need for each of us to contribute to the conservation of several non-renewable energy sources is constantly emphasised in news headlines. Stainless steel is now employed in a variety of applications that could minimise the need for fossil fuels, such as:

“Stainless steel (SS) condensing boilers have a 100% efficiency rating”. Condensing boilers frequently use stainless steel in their construction. The most energy-efficient heating method is a condensing boiler, which has a 100% efficiency rating. Corrosion resistance is crucial because stainless steel is needed because of the condensation that takes place during the procedure.

Rooftop solar panels encourage the adoption of renewable energy sources rather than only reducing the use of fossil fuels. Versions made of stainless steel can supply a sizable portion of the energy required to produce hot water

and space heating. Including solar panels onto a building's cladding or roofing may enhance its aesthetic appeal.

Long term energy can be obtained from fuel cells. The fuel cell converts energy into electricity very similarly to a battery. With just one emission water they produce heat and electricity using either natural gas or hydrogen. The electrodes, which are stronger, more easily manufactured, and less expensive than ceramic counterparts, are supported by stainless steel. Fuel cells are frequently used in a range of applications, including household heating systems and automobiles.

• *Keeps Water Clean*

The preservation of pure water is crucial for both the ecosystem and our health. You might utilise stainless steel to make water cleaner. Drinking water systems that use stainless steel (SS 304) pipes help to maintain high quality standards and clean water. Stainless steel ensures that no surface on which germs can grow forms and maintains enduring hygiene. Proper selection will reduce the possibility of any localised corrosion, which almost eliminates water contamination when it comes into touch with stainless steel. The easiest material to utilise is stainless steel because of its longevity and ease of upkeep. To minimise malfunctions and increase service life, stainless steel is used.

• *Reduces Waste*

Because the composting process emits a lot of corrosive gases, stainless steel is the best material to utilise for this process. Stainless steel may be used to reduce the amount of waste gases and materials given off, as well as the disposal of waste products. In addition, stainless steel is more economically appealing due to its durability over a lengthy period. Due to its usage in the recycling of paper and cardboard, stainless steel significantly contributes to both the reduction of waste steam and the preservation of trees.

➤ *No Damage to Humans & Environment*

Stainless steel is not harmful in any sort, the goodness of this metal is driven by its quality. Stainless steel is basically a metal alloy, which is a mix of chromium, nickel, silicon, and carbon. Steel produces no harmful toxins or chemicals and easily recovered from the environment using magnets.

III. LIFE CYCLE OF STEEL IN THE CIRCULAR ECONOMY

A true circular economy cannot exist without a life cycle approach. During a well-structured circular economy, the industry has significant competitive advantages over competing materials. These benefits are defined by four keywords:

➤ *Reduce:*

Reduced product weight, and thus the amount of material used, is critical to the circular economy. Steelmakers have drastically reduced the number of raw

materials and energy required to make steel over the last 50 years by investing in technology, research, and good planning. Furthermore, the steel industry is actively encouraging and developing the use of high-strength and advanced high-strength steel grades in a variety of applications. Because less steel is required to provide functionality and the same strength, these grades enable light weighting applications ranging from automobiles and wind turbines to construction panels.

➤ *Reuse:*

Steel may be reused or repurposed in a variety of ways, with or without remanufacturing, due to its endurance. Buildings, railroad rails, automobile parts, and several other uses already experience this. Reusing steel goes beyond its original purpose; it has been done since the dawn of time (turning swords into ploughshares). Reuse happens in industries where it is theoretically possible to do so without endangering warranties, safety, or mechanical capabilities. Reuse rates will rise as resource efficiency, eco design, and design for reuse and recycling become more popular.

➤ *Remanufacture:*

Many steel products, such as automotive engines and wind turbines, can be remanufactured for reuse to take advantage of the durability of steel components. Remanufacturing restores durable used products to like, new condition. It differs from repair, which is a process limited to making the product operational, as opposed to thorough disassembly and restoration with the possible inclusion of new parts.

➤ *Recycle:*

Since the beginning of the steel business, recycling has been practiced. Steel can be recycled endlessly to create new steel items in a closed material loop and is 100 percent recyclable. The fundamental qualities of the original steel are retained in recycled steel. Steel's magnetic properties make it simple and economical to recover steel for recycling from virtually any waste stream and the high value of steel scrap ensures that recycling will be profitable. The most recyclable material in the world is stainless steel. Stainless steel is a totally recyclable material that can be recycled endlessly to produce new items in a closed loop manufacturing process. The original steel's essential qualities are preserved in this recycled material.

➤ *The Life Cycle Assessment (LCA)*

Life cycle assessment (LCA) is a tool that enables us to measure the holistic environmental impact or performance of a product at each stage in its life cycle. It provides a measure which can be used to compare the environmental sustainability of similar products and services which have the same function. A life cycle assessment (LCA) of a steel product looks at resources, energy and emissions, from the steel production stage to its end-of-life stage, including recycling.



Fig 1 The Life Cycle of Steel

Source: World Steel (<https://worldsteel.org/steel-topics/life-cycle-thinking/>)

➤ *LCA Generally Comprises Four Stages:*

- *Objective and Scope Definition:* Describe the study's objectives and parameters.
- *Life Cycle Inventory (LCI):*
The gathering and analysis of data to produce an inventory (a list of inputs and outputs) of the materials, energy, and emissions associated to the under-investigation product.
- *Life Cycle Impact Assessment (LCIA):*
Determine the probable environmental effects based on a product or system's life cycle inventory. The global warming potential (GWP), which describes greenhouse gas emissions expressed in terms of CO₂ equivalents, is one of the impacts that is most frequently mentioned.
- *Interpretation:*
List the important environmental problems, draw conclusions, and offer suggestions.

IV. ENVIRONMENT FRIENDLY RECYCLABLE STEEL

Steel is generally not among the items that come to mind when thinking of environmental friendliness. When it comes to being environmentally friendly, stainless-steel grade 304 has that potential. Metal itself is benign, even though it is used to make various machinery that might damage the environment. The remaining metals are created by combining those elements, many of which are naturally existing in the earth. As an illustration, steel is a nearly all-iron alloy. Nevertheless, the process of turning that iron into steel requires labour and produces waste and carbon dioxide.

➤ *Waste from Steel Manufacturing*

The main by-product of steel production is slag, a material that resembles rough metal. Slag is now nearly fully used for other purposes when it was originally considered to be simply waste. Slag is collected and sold mostly to construction industries. Once the steel making process is complete so that it may be used to make cement.

➤ *Effects of Steel on Water*

Water is utilised extensively throughout the production of steel, mostly for cooling, desalting, and cleaning. There are many other particles that do end up in this water, particularly coke. However, a filtration procedure can get rid of almost all of this, making 98% of the water recyclable and reused. Evaporation from the cooling process is the main cause of water loss.

➤ *Recyclability of Steel*

Steel is very recyclable for a variety of reasons. It is simple to take out of waste streams because of its special magnetic feature. Because of this, steel are the materials that are recycled the most globally. The fact that steel doesn't degrade is the finest thing about recycling it. To put it another way, any form of steel may be recycled numerous times and still be utilised to produce steel that is of the greatest grade. In the end, recycled materials make up 42% of the crude steel that is produced. Only recycled steel may be used in an electric arc furnace (EAF) technique of making steel.

➤ *Air Pollution*

The production of steel has drawn criticism in several areas, including air pollution and carbon emissions. Nevertheless, recently, this has undergone a significant adjustment. During the 1960s, both energy use and carbon dioxide emissions have reduced by 50%. Even more has been done to limit dust emissions. Industry experts are trying to lower these figures even more in the future. Modern society benefits greatly from steel, which is used in everything from skyscrapers to welded rings.

V. UTILITY OF STAINLESS STEEL

Choosing stainless steel is a sensible decision after thorough and exact research of its sustainability. As society and governments pay greater attention to environmental and economic issues, stainless steel use has increased at the greatest rate of any material in the world. These are a few examples of applications with a focus on sustainability:

➤ *A Practical Long-Term Solution to the Problem of Water Loss from Leaking Water Pipes*

There has been a significant increase in water usage when using stainless steel pipes. To eliminate leaky pipes and conserve water.

➤ *Stainless Steel in Street Furniture*

Stainless steel offers a perfect option in a variety of urban building applications, including lampposts, barriers, handrails, artwork, and other types of street furniture. Stainless steel is strong, attractive, safe, and hygienic. For

public bodies looking for cost-effective long-term solutions, it offers a lengthy usable life and a reasonably low life cycle cost. The environmentally friendly option for street furniture is stainless steel. This brochure provides descriptions of each application as well as information on locations and material sources while showcasing modern concepts and examples from around the globe.

➤ *Stainless Steel in Infrastructure*

The reliability of energy and drinking water supply, the ease of travelling by land, rail, air or water, the secure sewage and waste disposal all have a significant impact on the quality of our daily lives. These factors also affect how we live and work. Stainless steel is used extensively in various industries but is frequently ignored. The endurance of infrastructure buildings and installations is largely dependent on the material choice. Maximum availability and minimal life cycle costs are made possible by it. The current booklet provides examples of how stainless steel is used in various global infrastructure applications. It will stimulate the sharing of best practices and motivate government officials, business financiers and design engineers to take the stainless-steel option into consideration anytime they start an infrastructure project.

➤ *The Advantages of Stainless Steel for the Elderly*

The average life expectancy is rapidly rising. As the population ages, society must be ready to meet the unique requirements of the elderly. Steel is appealing to users as well as making living spaces safer and cosier. Its resistance to corrosion makes it ideal to transport chemicals, liquids, and food products. The low maintenance of stainless steel also makes it an easy and cost-effective metal to clean and sustain. Stainless steel is preferred in clean and sterile environments as it is simple to clean and does not easily corrode.

➤ *Stainless Steel used in Architectural Applications*

The potential of stainless steels for architecture and construction, in both visible and non-visible uses, was only just being realised by architects. Some recent examples are presented in the International Stainless-Steel Forum (ISSF) publications. They may differ in terms of their extent, purpose, and materials employed, but they all belong to a long-lasting architectural design.

➤ *Stainless Steel in Agricultural Applications*

Stainless steel is used on farms in a variety of applications, replacing plastics, light metals, and most importantly galvanized steel. These uses range from basic feeding pails to the most sophisticated completely robotized milking equipment. Among the many agricultural uses for stainless steel are fences, gates and partitions, as well as for feeding, watering, electrical, mechanical equipment, skin care products, dairy farming, auxiliary equipment, tanks for slurry and wastewater.

➤ *Stainless Steel in Self-Service Machines*

Self-service devices, such as dispensers, vending machines, ticket machines, etc., must adhere to certain standards. Stainless steel has the perfect profile and comes

in a wide range of appropriate grades. The benefits of using stainless steel for self-service equipment and some typical uses, including vending machine fronts, keypads, mechanical components, beverage and drinking water dispensers and vending machines, milk vending machines, ticket machines, access control, and coin-operated controls. Steel grade 304 has high corrosion resistance among others, however it is an excel choice when the body of the machine shall be painted. It does not require primers or other protective layers prior to coating.

➤ *The use of Stainless Steel in the Water Supply*

Stainless steel is the best material for use in contact with drinking water in all processes, from extraction to home plumbing, due to its inert and corrosion-resistant nature. Stainless steel is a metal that can be used with any typical drinking water composition. The applications for stainless steel in interaction with drinking water include water intake, water preparation, water storage, and water distribution.

➤ *Clean Cooking with Stainless Steel*

One of the biggest but least well-known killers in the world is chronic exposure to smoke from traditional cooking methods. A part of the answer to this issue is this new stainless steel. Following a discussion of the negative impacts on health and the environment, it introduces many types of alternative stoves, including those that use forced air or the sun for heat.

➤ *Durable, Hygienic and Recyclable for a Sustainable Future*

The new animation and booklet demonstrate how stainless steel contributes to a sustainable world across a variety of sectors, including transportation, healthcare, water supply, and food, since sustainability is about much more than just the environment.

➤ *Long Stainless-Steel Products for Applications Involving Alternative Energy and Energy Conservation*

One of the biggest challenges we face today is mitigating climate change. A wide range of technologies, including stainless steels, are needed to develop new energy sources and save energy. A new animation from ISSF describes the uses and applications of stainless steel.

➤ *The Production of Biogas with Stainless Steel*

A Sustainable Green Energy Solution. One of the most affordable sources of renewable energy is biomass. Corrosive substances come into touch with biogas production equipment. Stainless steels that have been properly specified can survive the corrosive substances in a biogas plant. This pamphlet highlights the applications where stainless steel is frequently used, including digesters, pumps, valves, agitators, pipelines, and fittings.

➤ *Tunnels with Stainless Steel*

Stainless steel is finding increasing use in tunnels for its fire and corrosion resistance properties and long maintenance free life. ISSF has launched an animation and brochure in the Sustainable Stainless series which provides

detailed case studies to demonstrate why stainless steel is becoming the material of choice in road, rail, metro, and long subsea tunnels.

➤ *Sustainable Duplex Stainless Steel Bridges*

Due to their superior mechanical qualities, duplex stainless steels are being used more and more as structural components in construction and architecture. They have yield strengths that are more than twice as strong at room temperature as typical austenitic stainless steels that are not alloyed with nitrogen. They have begun to play a more significant role in bridge building in recent years, particularly in situations where the necessity for strong load-bearing capacity and particular environmental circumstances coexists.

➤ *The use of Stainless Steel in Solar Energy*

The most recent industry standards for solar energy harvesting, including stainless steel products. It gives designers a rundown of the technical characteristics of stainless steel as well as information on the most recent choices for capturing solar energy in stainless steel.

➤ *The use of Stainless Steel in the Dairy Sector*

To satisfy the demands of milk product consumers worldwide, the modern dairy industry needs to use equipment made of corrosion- and rust resistant stainless steel. The Sustainable Stainless series 304 describes the function of stainless steels in the dairy industry and how they help create a sustainable diet.

➤ *Solar Cooling Case Study: Cooling with Heat*

The Stainless-steel material plays a major role in a new generation of adsorption chillers, the heart of environmentally friendly cooling equipment. A significant percentage of the energy consumed is used to keep rooms within a specific temperature range. Conventional cooling systems utilize a compressor, which is usually electrically driven and hence energy intensive to operate.

➤ *Sewage Treatment Facilities that use Stainless Steel*

Wastewater is a resource that is created when water is used, and it should be properly treated. You may find more specific information about where and why stainless steel is used in sewage treatment plants. The advantages of this technology from a technical and financial standpoint are well known to operators and equipment manufacturers utilized in them.

➤ *Stainless Steel Desalination*

A material that can withstand the intense corrosion brought on by brine and sea water is necessary for successful desalination. The desalination industry's sustainability profile is further enhanced using stainless steel (SS) in the production of fresh water. Stainless steel is an excellent option for the environment and the economy because of its longevity, high amount of recycled material, low maintenance needs and 100% recyclability at the end of its life.

➤ *Stainless Steel with Rail and Cars*

A good illustration of how the social, economic, and environmental aspects of material selection interact to make a technical solution sustainable is the use of stainless steel in the construction of railcars, which raises the rail industry's sustainability profile.

➤ *Other Application*

Application for preserving the environment and people's health, air, water, and human health are given particular attention. uses in the home and office, applications for transportation, such as those for cars, trains, ships, aero planes construction, architecture, equipment, applications for structural, interior- and exterior-use, Industrial uses and timeless artwork.

VI. STAINLESS STEEL THE SUSTAINABLE CHOICE

According to the Zero Waste International Association, Zero waste refers to the conservation of all resources through responsible production, consumption, reuse, recovery of goods, packaging and materials without burning and without releasing any pollutants into the air, water, or land that could endanger the environment or human health. If stainless steel is utilized for a project, it will be produced ethically, will require little upkeep over the course of its long lifespan and can be recycled numerous times without losing any of its quality.

VII. CONCLUSION

Stainless steel 304 has enormous advantages as compared to other materials, having high strength and corrosion resistance it has become the most preferred material. Due to their lack of hazardous run off and lack of toxic coating, stainless steel is a completely recyclable and environmentally friendly material. Businesses and individuals may frequently make a significant difference by choosing stainless steel over non-recyclable materials. The main building material used worldwide for green construction is stainless steel. When compared to other materials, it has a very low environmental impact, and because it is used and recycled, it has a very low impact on human life. It will survive the duration of the project if the stainless steel is correctly chosen and properly maintained.

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