

A review of corrosion in cast iron pipes used in drinking water distribution systems

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Abstract: Pipe cast iron water supply pipe is made by high-speed centrifugal casting of cast iron liquid with nodule agent. Ductile iron pipe has the characteristics of iron nature, steel performance, good ductility convenient installation, good corrosion resistance. Mainly used for transporting water, gas and oil in municipal, industrial and mining enterprise. Nodular cast iron pipe is the first choice for water supply pipeline with high cost performance. Ductile cast iron have a diameter of 80 to 2200mm and length of 5m, 6m and 8m compared to grey cast iron pipe ductile cast iron pipe has the advantages of high strength, good toughness, thin wall and lower metal consumption and high pressure resistance. one of the advantage of cast iron pipes is their longevity With proper installation and maintenance they can last for decades, even up to a hundred years. They are also known for their sound dampening properties. which help in reducing noise caused by flowing water. However, cast iron pipes have disadvantages. They are heavy, making them difficult to transport and install. They are also prone to rusting and corrosion with time, particularly if not properly maintained. Furthermore, cast iron pipes have a smooth interior that can allow sediment and other material to accumulate, resulting in blockages and reduced flow. Corrosion of water pipelines is a serious issue that affects everyone. It's also a tough issue.. The complexity of understanding this topic stems from the diversity of materials used, the wide range in water chemistry that is considered potable, the variety of methods for mitigating corrosion, and the interplay of these factors As a result, it is difficult to develop specific guidelines that are applicable to all situations, materials, and water. These factors affect both the dissolution rate and the stability of the protective.

Keywords: cast iron pipe, corrosion, drinking water.

INTRODUCTION

Most distribution system pipes are constructed of iron,. Cast iron is a robust and sturdy material that has been utilized in plumbing systems for millennia

Cast iron pipes are widely used in sewer and drainage systems because they can handle high pressure and are resistant to fire and corrosion. These tubes are created by pouring molten iron into a mold and allowing it to cool and solidify into the correct shape. According to studies conducted in this subject, one of the most common difficulties in distribution systems is corrosion of cast iron pipes.

In 2016, Tuan Son Nguyen revealed that sprinkler firewater systems with end caps usually fail. The reason for this is that the water inside the sprinkler systems freezes as the temperatures drop during the cold winter months. In this case, the flat upper piece of a sprinkler system's end cap fails and separates completely from the threaded body during final weaning. Water, as we all know, freezes when the temperature drops below zero. These conditions led to an increase in volume and the explosion of pipes and related components.

In 2023, Edward John discovered that grey cast iron water pipes were subjected to a variety of pressures and were described as multiaxial. Water pressure on the inner walls of pipes, as well as the weight of cars, have a significant impact over time. the multi-axle performance has not been described. In order for the tire to be able to address this gap, fatigue tests were conducted over an extended period of time. Furthermore as is well known, there are types of cast iron including grey, which has a disadvantage in that it has a significant failure rates when compared to other types of pipes. This demonstrates the United Kingdom's commitment to reduce leakage rates by half in the future. The purpose of this research is to study fatigue scale through it, it gives an indication of fatigue in water pipes. Through a set of chart to measure the fatigue he discovers the exposure of pipes to uniaxial stress behavior.

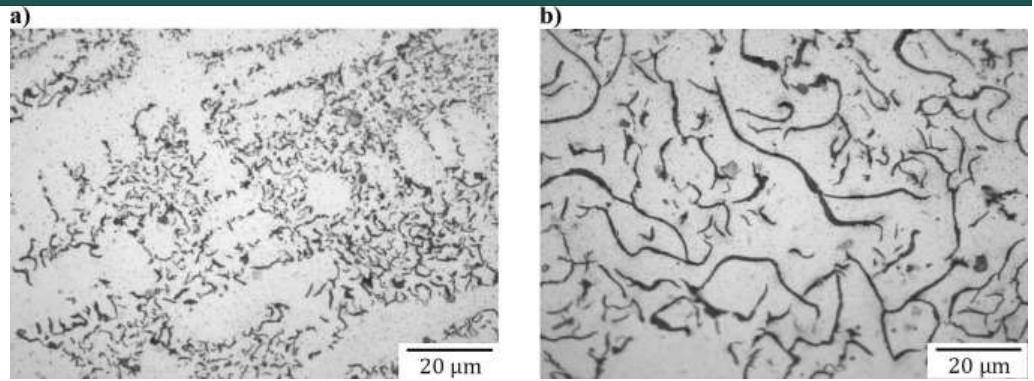


Figure :magnification photographs of typical graphite microstructures from the bs416-2 pipe.

Peng Q's 2016 research explains how items utilized in drinking water distribution systems that are subjected to nitrogen sterilization are affected by corrosion that occurs in cast iron pipes,, the results showed that the corroded effluent was treated by special reactions with corroded cast iron coupons which boosted the nitrogen compound compared to the effect of a larger amount of dissolved organic carbon. This indicated that the iron partials served as a protective environment for microorganisms.

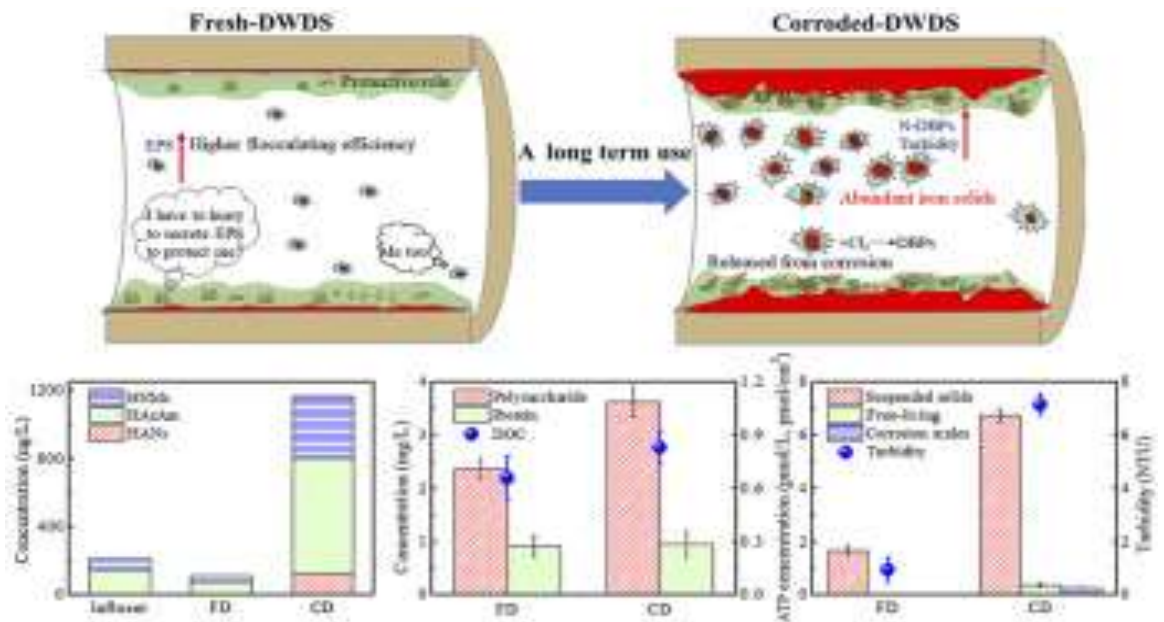


Figure2: show a comparison of the condition of two pipe models over a long time.

The purpose of disinfection is to stop infections that are spread through water. Drinking water contaminated by disinfection products greatly raises the risk of cancer. Compared to carbon molecules, nitrogen compounds are more hazardous. Atika Hossain Akhi discussed subsurface water distribution systems in 2021 a significant number of cast iron pipes are found in these systems. Furthermore, these pipes are almost fifty years old, which makes them outdated, deteriorated, and exhibiting signs of corrosion and rust. He continued, The water mains occupy a considerable portion of the pipeline so it need rehabilitation's systems. Throughout the past century, cast iron water main pipelines were widely utilized the aim of the current study is to assess the SIFs for corrosion and cracks on the external surface of underground cast iron pipe, as some of these pipes have already exceeded their service life and are deteriorating. subjected to internal pressure and surface load.in addition to in this study, Using FE analysis, the stress intensity factors (SIF) for semi-elliptical flaws on the outside surface of buried cast iron pipe are examined. The SIFs were assessed for load and crack alone. additionally Youyi Chen conducted research on the impact of bacteria in drinking water distribution networks in 2021, as well as the corrosion of cast iron pipes and how it impairs water quality., and it is well recognized that microorganisms pose a health risk. Chlorine is used to disinfect, but research has shown that old pipes have high rates of concentrations of

trihalogen antibiotics, which raises the danger of contamination from the pipes. Age-related corrosion in pipes leads to a process that produces bio flocculation between the biofilm, chlorine, and corrosive chemicals.

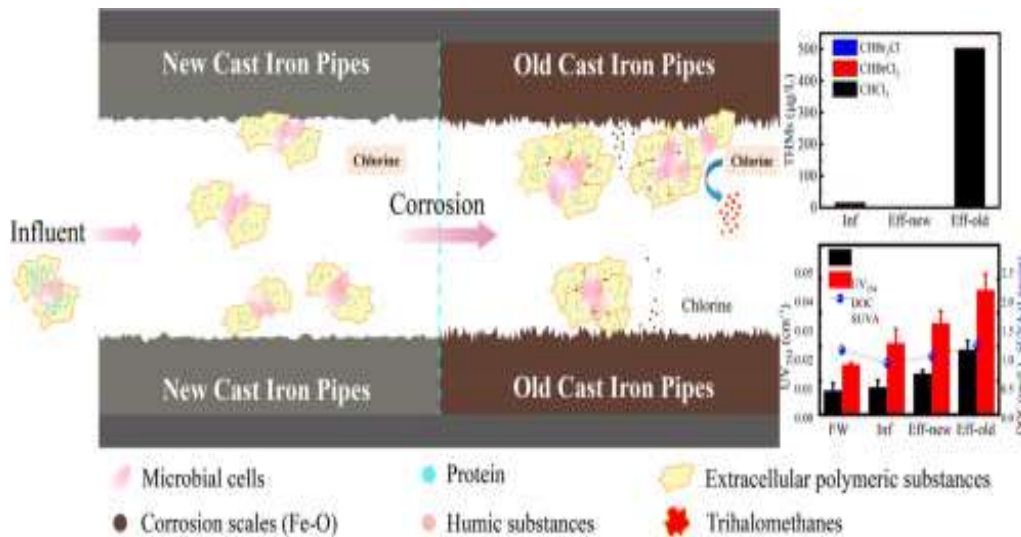


Figure.3 show the effect of aging on increasing corrosion rate.

Disinfection is used to provide drinking water that is pure, sterile, and free of illnesses. which embodies one of the most often employed methods in this context, chlorine is utilized for disinfection and sterilization due to its low cost, strong bactericidal properties, and chemical effectiveness.

Alcione dos Reis investigated in 2023 Improvements in aspheric iron alloy qualities have resulted in the development of more efficient materials due to advancements in cast iron alloy properties. particularly in the automobile sector. Due to this advancement, there is now a greater requirement for strong, resilient tools that can sustain cutting operations Research has been done on how these materials affect the tools' lifespan, which is still crucial because these details have an immediate impact on output. Important materials include a variety of alloys, such as gray cast iron. and grey cast iron alloyed It is imperative to conduct a thorough analysis of how these materials affect tool longevity because it has a direct bearing on productivity and The purpose of this study is to look at how long a tool lasts when face milling different high strength cast iron alloys. There were two complete factorial 23 designs that had a cutting speed range of 230 (-) to 350 (+) m/min. In the same year, R. Lacalle explored how to detect flaws in cast iron pipes He found that by conducting a pressure test inside a factory facility, the pipe's problems could be found before it was put into use. Furthermore, in order to identify the reasons for the problem, Visual inspection combined with mechanical and chemical study of the material He added, The failure occurred during the pressure test performed on the entire pipe line, once it had already been installed on the ground, and when the applied pressure exceeded 2.0 MPa, This is where you should be aware of the fact that every single pipe stretch has already undergone a preliminary in-plant pressure test.

Also A physical probabilistic failure model for buried cast iron pipes is presented in M. Moglia's research from 2023. This model is based on the fracture mechanics of the pipe failure process. A model like this is helpful for managing underground pipeline assets. He continued, saying that infrastructure has grown at a rapid pace and that the population outnumbers it. For example, water reticulation systems were built during the height of the Second World War.. In this study, cast iron failures were identified using models. These models would be very helpful because it requires highly particular data regarding pipes and failure. vital in areas under authority. The issues become more noticeable when environmental operational loads is not understood.

Ming Li conducted research on the health dangers associated with drinking water that has changed color in 2024 The study focused on the potential for heavy metals, organic compounds, bacteria, and carcinogenic organics to cause diseases, including cancer. It is common knowledge that cleaning activities have an impact on people's lives, safety, and health. . This study contains new findings on assessing the size of all non-durable cast iron, contaminants, and enhanced cleaning approaches. Pipe scales are primarily made up of corrosion scales, deposits, heavy metals, bacteria, and organic materials, with corrosion scales and deposits being the predominant locations of heavy metal accumulation and release This analysis concluded by reviewing current development in the field of water pipes, covering the key sophisticated cleaning technologies and the formation of corrosion scales

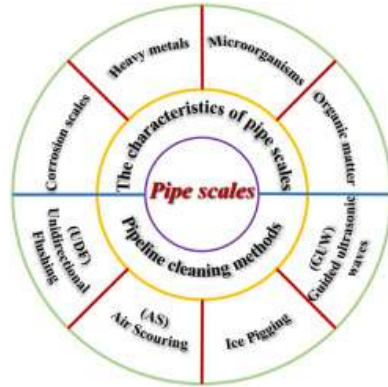


Figure-4- The characteristics of pipe scales.

For example, Carlos Jara - Arriagada conducted a scale study on the usage of cast iron in water supply networks and discovered that failure rates increase at the beginning or throughout the corrosion stage, These pipes should be fixed or replaced As is known Replacing or rehabilitating pipes requires significant resources and time so it is critical to investigate the impact in operational processes on the failure rates of this type of aging pipe. Most cast iron pipes are nearing the end of their useful lives., During which failure is rapidly increasing this stage is known as the corrosion stage and the figure below each indicates System's components Have degraded and Must be fixed or replaced. As previously stated, the main concern with the restriction on replacement or re-rooting is the high cost.

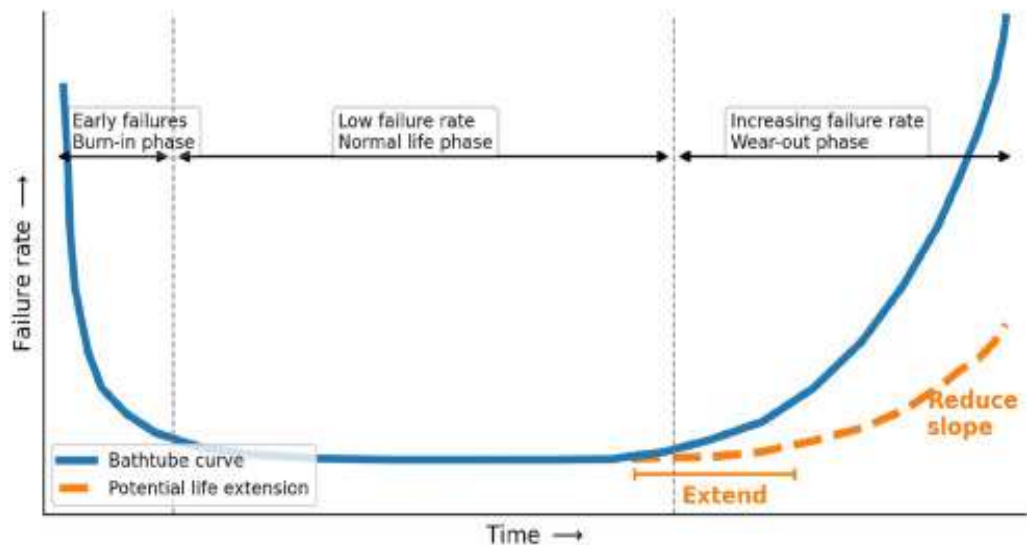


Figure -5- the relationship rates over time .

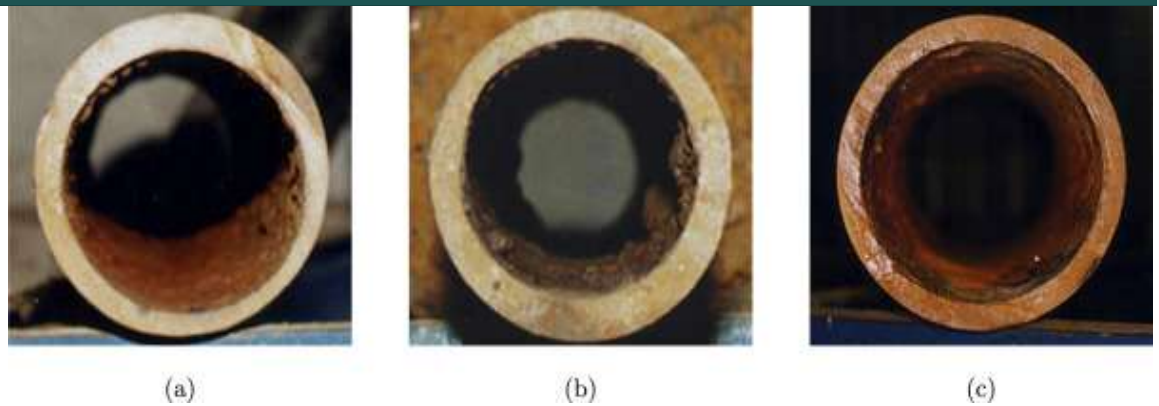


Figure - 6 -

Pipe wall thickness fluctuates and is not uniform due to manufacturing techniques. (a) and (b) Significant non-uniformity in pipe wall thickness, possibly caused by horizontal or vertical pit casting processes. c) A spun cast iron pipe

Plastic pipes are used as an alternative cast iron pipes for drinking water to compare the two types, Plastic pipes with good specification are more expensive than cast iron, plastic pipe do not need any ant-corrosion while cast iron pipe cost more with the addition of ant-corrosion .in the terms of constructing due to the light weight of the plastic which facilitates lifting installation compered to cast iron.

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